

من ذكريات العمل (51)

مشروع قناطر نجع حمادى الجديدة

المنظومة اللوجستية ومعدات صب الخرسانة فى مشروع قناطر نجع حمادى

المقدمة

تُعد أعمال الخرسانة في مشروع قناطر نجع حمادي الجديدة واحدة من أكبر وأعقد عمليات الصب الخرساني التي نُفذت في مشروعات الري والمنشآت الهيدروليكية في مصر الحديثة، حيث تجاوز إجمالي كميات الخرسانة المنفذة أكثر من 385 ألف متر مكعب موزعة على عناصر استراتيجية تشمل الهويس الملاحي، والمفيض، ومحطة توليد الكهرباء، والأساسات الضخمة للقناطر.

لم تكن التحديات المرتبطة بهذا المشروع مرتبطة فقط بحجم الكميات الهائلة، بل بطبيعة المشروع ذاته؛ فقد تم تنفيذ الأعمال داخل مجرى نهر النيل وفي بيئة إنشائية معقدة تفرض قيودًا تشغيلية صارمة. هذه القيود استلزمت دقة زمنية شديدة في التنفيذ، واستمرارية في إمداد الخرسانة دون توقف، وتنسيقًا متواصلًا بين عشرات الأطراف والمعدات، وتحكمًا صارمًا في الجودة ودرجات حرارة الخرسانة الكتلية (Mass Concrete)، بالإضافة إلى جاهزية كاملة للعمل بنظام التوريدات على مدار الساعة لمواكبة المواعيد الرئيسية للمشروع. (Key Dates)

لذلك، لم تكن عملية صب الخرسانة في هذا المشروع مجرد نشاط تنفيذي روتيني، بل كانت منظومة لوجستية متكاملة تجمع بين محطات الخلط المركزية، وشبكات النقل والضخ، وأساطيل المعدات المتنوعة (خلاطات، مضخات، أوناش، هزازات)، والتخطيط الإنتاجي اليومي والساعي، وإدارة الموارد البشرية الضخمة. وقد شكلت هذه المنظومة أحد أهم عوامل نجاح المشروع في تحقيق برنامجه الزمني والوصول إلى مرحلة التشغيل بجودة وكفاءة عالية.

ولامكان شرح هذه الاعمال والالمام بما فيها من تفاصيل كثيرة وهامة ومتنوعة ولعدم الاطالة فقد يحتاج الامر الى اكثر من بوست.

وسنحاول تقسيم هذا العمل الى عدة اقسام بما ييسر للقارئ المتابعة

اولاً: الوثائق المرجعية للمشروع. (Introduction & Reference Documents).

- المستندات التعاقدية والمرجعية: (Contractual & Reference Documents) يتم العمل بها وفقاً للمواصفات الفنية الخاصة (Particular Technical Specifications) المجلد الثالث، الجزء الثاني، القسم الخامس الخاص بالخرسانة. ("Concrete") كما يتم التنسيق الكامل مع المخططات الإنشائية للخرسانة (Concrete Outline Drawings) ، وبيان طريقة العمل لصب الخرسانة (Method Statement for Concrete Placing)

- مرفق صورة من هذه المستندات

ثانياً :إنتاج الخرسانة وحركة النقل المرتبطة بمكوناتها

يتناول هذا الفصل تنظيم حركة النقل المتعلقة بإنتاج الخرسانة، ويقسمها بوضوح إلى قسمين رئيسيين:

حركة النقل خارج الموقع (Off-Site) والتي تشمل نقل المواد الخام من مصادرها إلى موقع المشروع، وحركة النقل داخل الموقع (On-Site) والتي تغطي نقل هذه المواد ومعالجتها وتجهيزها داخل نطاق العمل وصولاً إلى محطة الخلط. الهدف الأساسي هو ضمان سير العمل بشكل منظم دون معوقات لوجستية، ويتميز التخطيط باستخدام أسطول متنوع من المعدات يناسب كل مادة.

فيما يخص حركة النقل خارج الموقع،

تم تخصيص مسارات ووسائل محددة لكل مادة من مواد الخرسانة.

بالنسبة للركام الناعم (الرمل)، يتم نقله من المحاجر في منطقتي البلايش ونجوع مازن بمركز دار السلام بمحافظة سوهاج على مسافة من 20 الى 25 كم إلى محطة الغسيل والمعالجة باستخدام ما بين 15 إلى 20 شاحنة، بمعدل يتراوح بين 40 و 50 رحلة يومياً، وسعة كل شاحنة تتراوح بين 10 و 15 متراً مكعباً.

أما الركام الخشن (الزلط) فيتم نقله من المحار بمنطقة البلايش مباشرة إلى محطة الخلط باستخدام 8 إلى 10 شاحنات صغيرة (سعة 10-12 م³) أو 4 إلى 6 مقطورات كبيرة (سعة 25-30 م³)، ليصل عدد الرحلات اليومية إلى ما بين 30 و 40 رحلة.

بالنسبة للمواد الإسمنتية، يتم نقل الأسمنت من المصنع في السويس إلى محطة الخلط عبر 20 إلى 30 مقطورة صهريج، بسعة تتراوح بين 30 و 40 طناً، وبمعدل 15 إلى 20 رحلة يومياً.

كما يتم نقل الرماد المتطاير (Fly Ash) من ميناء سفاجا إلى منطقة تخزينه في المشروع (منطقة القوصه) بواسطة 10 إلى 12 مقطورة صريج بنفس السعة تقريباً وبنفس عدد الرحلات.

وأخيراً، يتم تسليم الإضافات الكيميائية للخرسانة باستخدام شاحنتين مخصصتين، سعة كل منهما تتراوح بين 10 و 15 ألف لتر، مع إمكانية استخدام خزانات إضافية سعة 1000 لتر أثناء فترات الذروة.

أما حركة النقل والعمليات داخل الموقع

فتم تصميمها لتكون مكملة للحركة الخارجية وضمان استمرارية التغذية لمحطة الخلط. بعد وصول الرمل الخام وغسله في محطة الغسيل، يتم نقله إلى محطة الخلط عبر 2 إلى 4 شاحنات فقط، ولكن عدد الرحلات اليومية يصل إلى ما بين 50 و 60 رحلة نظراً لقصر المسافة. ويتم استخدام 2 إلى 3 لودر للتغذية والتحميل داخل محطة الغسيل.

بالنسبة للركام الخشن، تم التخطيط للاحتفاظ بمخزون احتياطي ضخم يتراوح بين 30,000 و 35,000 متر مكعب من الزلط بالقرب من محطة الرمل، ويتم استخدام هذا المخزون فقط في حالات الطوارئ لتجنب نقص المواد، وعندها يتم استئجار 4 إلى 6 شاحنات لنقله إلى محطة الخلط عبر حوالي 60 رحلة.

الفصل الثالث : محطات خلط الخرسانة داخل موقع المشروع (On-Site Batching Plants)

يعتمد المشروع في إنتاج الخرسانة على ثلاث محطات خلط مركزية مثبتة في الموقع لضمان التدفق المستمر للعمل. تشمل هذه التجهيزات محطتين من طراز (C.S Johnson 430) أمريكية الصنع، بقدرة إنتاجية تصل إلى 65 متر مكعب في الساعة لكل منهما

بالإضافة إلى محطة (Elba) ألمانية الصنع بقدرة 60 متر مكعب في الساعة.

هذه المحطات مدعومة بنظام متكامل لتبريد المياه ووحدات لإنتاج الثلج (Flake Ice)، وهو أمر حيوي للتحكم في درجة حرارة الخرسانة وضمان مطابقتها للمواصفات الفنية، خاصة في الأجواء الحارة التي قد تؤثر على جودة الخلطة.

عدد المحطات وأسباب التعدد

لم يكن إنشاء محطتين رفاهية تشغيلية، بل ضرورة هندسية ولوجستية، وذلك لتحقيق عدة أهداف رئيسية:

- تأمين استمرارية الإنتاج وعدم توقف الصب في حال تعطل إحدى المحطات
- توزيع الأحمال الإنتاجية خلال فترات الصب الكبرى
- تقليل مسافات النقل داخل الموقع
- توفير احتياطي إنتاجي (Backup Capacity) للصبات المستمرة

وبذلك أصبحت منظومة الإنتاج قادرة على العمل حتى في حالات الطوارئ أو الصيانة المفاجئة دون التأثير على برنامج الصب.

المكونات الرئيسية لمحطة الخلط

بالنسبة للركام، يتم توريد الرمل إلى محطات غسيل قريبة من الموقع، ثم تخزينه في صناديق مغطاة بمظلات خفيفة لحمايته من أشعة الشمس المباشرة التي قد ترفع درجة حرارته. أما الزلط بمقاسيه (4-16 مم و 16-32 مم) فيتم غسله في الموقع ثم تخزينه في صناديق منفصلة مع تغطيتها أيضاً. وبالنسبة للأسمنت، تم تركيب 5 صوامع سعة كل منها 140 طناً لكل محطة خلط، ليصبح إجمالي سعة تخزين الأسمنت 700 طن للمحطة الواحدة. أما الرمال المتطاير (Fly Ash) المستورد من الهند، فيتم تخزينه في صومعة واحدة سعة 140 طناً لكل محطة. وتُخزن الإضافات الكيميائية في خزانين سعة كل منهما 2000 لتر لكل محطة، بالإضافة إلى خزان رئيسي سعة 40 ألف لتر في الموقع.



آلية النقل والتوصيل للموقع تتم عملية النقل عبر أسطول مكون من 15 شاحنة خلط (Truck Mixers) بسعة 8 متر مكعب لكل منها. في حالات الطقس الحار، عندما تتجاوز الحرارة 32 درجة مئوية، يتم عزل أسطوانات الشاحنات أو طلائها باللون الأبيض لتقليل اكتساب الحرارة أثناء الرحلة. عند وصول الشاحنة إلى نقطة الصب، تخضع الخرسانة لاختبارات فورية تشمل قياس درجة الحرارة واختبار القوام (Slump Test) بواسطة فني المختبر، ولا يسمح ببدء الصب إلا بعد التأكد من مطابقة الخرسانة لكل المعايير الفنية وتسجيل أوقات الوصول والمغادرة لضمان عدم تجاوز الزمن المسموح به للخلط.

منظومة التبريد المتكاملة

نظراً لموقع المشروع في صعيد مصر حيث ترتفع درجات الحرارة بشكل كبير خلال معظم أيام العام، تم تجهيز محطات الخلط بأنظمة تبريد متطورة للتعامل مع الخرسانة الكتلية (Mass Concrete) التي تتطلب تحكماً دقيقاً في درجة حرارتها. تشمل هذه المنظومة ثلاث حاويات لمحطات تبريد المياه، تنتج كل منها 6.4 أمتار مكعبة من المياه المبردة في الساعة بدرجة حرارة 5 درجات مئوية.

وبالإضافة إلى ذلك، تم تركيب حاويتين لإنتاج الثلج المجروش، تنتج كل منهما 1.75 طن في الساعة، مع حاويتين للتخزين بسعة 23 طناً لكل منهما، ليصبح إجمالي سعة تخزين الثلج 46 طناً. يضمن هذا النظام خفض درجة حرارة الخرسانة الطازجة إلى المستويات المطلوبة، مما يمنع حدوث الشروخ الحرارية ويحافظ على جودة ومتانة المنشأ على المدى الطويل.

نظام توليد الطاقة الاحتياطية

تم تجهيز موقع محطات الخلط بمجموعة كبيرة من المولدات الكهربائية لضمان استمرارية العمل حتى في حالة انقطاع التيار الكهربائي الرئيسي. حُصصت 3 مولدات بقدرة 350 كيلو فولت أمبير لتشغيل محطات الخلط، بالإضافة إلى مولدين احتياطيين بقدرة 320 كيلو فولت أمبير.

كما تم تركيب 4 مولدات بقدرة 300 كيلو فولت أمبير لتشغيل محطات غسيل الركاب، و 4 مولدات أخرى بقدرة 500 كيلو فولت أمبير لتشغيل أنظمة التبريد وإنتاج الثلج. ولزيادة درجة الأمان، تم توفير 4 مولدات احتياطية بقدرة 250 كيلو فولت أمبير للاستخدام في الحالات الطارئة. هذا التكرار في مصادر الطاقة يضمن عدم توقف الإنتاج لأي سبب من الأسباب، ويحمي الخرسانة من التلف نتيجة التوقف المفاجئ للخلط.

أردت التذكير بهذه الأعمال وشكر كل من ساهم فيها والترحم على من انتقل الى جوار ربه رحمهم الله رحمة واسعة .

المصادر:

- يوميات وملاحظات وصور اثناء التنفيذ
- مستندات العقد
- من مستندات المقاول Method Statements









الفصل الرابع: اعمال الصب والتشطيب والمعالجة

تصنف أعمال الصب إلى خرسانة الأساسات (foundation slabs) وتُعتبر خرسانة كتلية (mass concrete) ، وخرسانة العناصر المرتفعة، وخرسانة البلاطات، والخرسانة الثانوية (second stage concrete)، والخرسانة سابقة الصب (precast concrete) ، وأخرى.

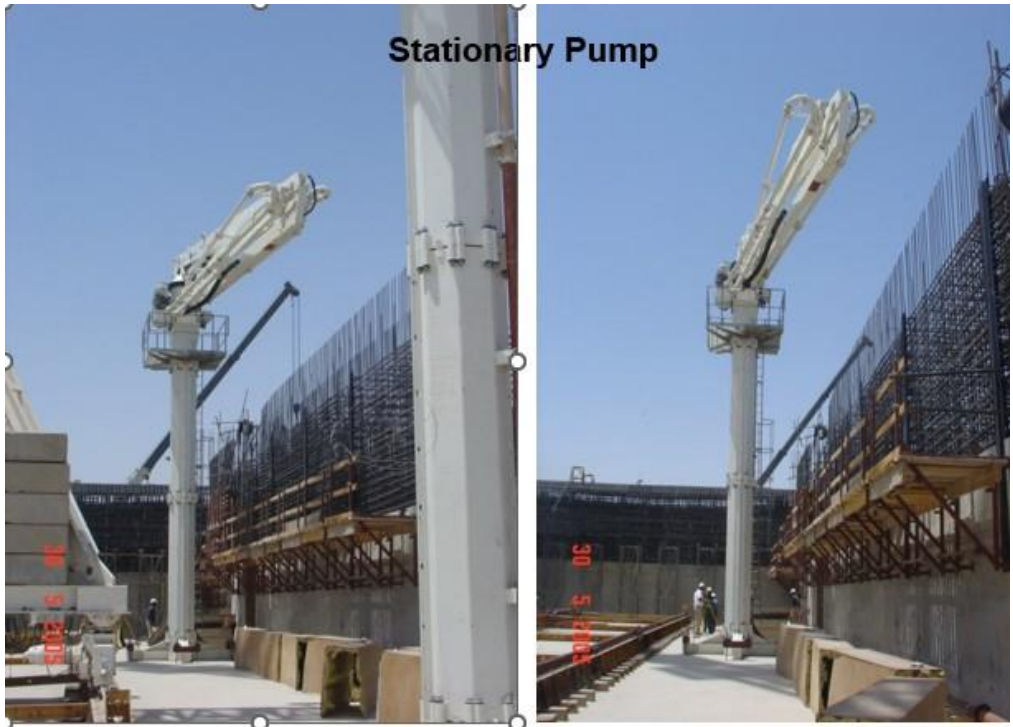
الموارد والمعدات (Resources and Equipment)

تشمل قائمة المعدات الرئيسية ما يلي:

- معدات صب الخرسانة: (Concrete Conveying Equipment) مضختان متنقلتان على شاحنات (mobile pump trucks) بطاقة 80 م³/ساعة ونصف قطر عمل 32 متر.
- مضخة ثابتة (stationary pump) بطاقة 80 م³/ساعة.
- ثلاثة أذرع صب (placing booms) بنصف قطر عمل 32 متر.
- أربعة موزعات دائرية (round distributors) بنصف قطر عمل 10 متر
- 300 متر من مواسير الضخ بقطر 125 مم
- سطلين للرافعة (crane buckets) سعة 750 لتر لكل منهما.
- معدات دمك الخرسانة: (Concrete Compaction Equipment) خمسة وعشرون هزازًا داخليًا (internal vibrator) بقطر 65 مم (كهربائي)، وخمسة عشر هزازًا بقطر 57 مم (كهربائي)، وعشرة هزازات بقطر 45 مم (كهربائي)، وعشرون محوّلًا (converter) ، وخمسة هزازات بقطر 65 مم تعمل بالبنزين.
- معدات تشطيب الخرسانة: (Concrete Finishing Equipment) عشرون مجرفة يدوية (hand trowels) ، وخمسة ألواح تسوية (screed boards) ، وثلاث مجفات كهربائية (power trowels) خلفية المشغل بقطر 900 مم، وأربع مقشطة (scabblers) ، وثلاث غسالات ضغط عالي (high-pressure cleaners) ، وثلاث مكانس كهربائية. (vacuum cleaners)
- معدات معالجة الخرسانة: (Concrete Curing Equipment) ست خزانات مياه سعة 5 – 10 م³، وخمس حصائر من الجوت (jute mats) ، و500 متر من خرطوم المياه PVC بقياس 3/4 بوصة، وسبع فوهات رش (spraying nozzles) ، و1500 متر من رقائق PVC بسمك 0.3 مم.

يتم صب الخرسانة باستخدام مضخات ومعدات توزيع خرسانة (concrete pumping and distribution equipment). بالنسبة للصبات الكبيرة للأساسات التي يتجاوز حجمها 500 متر مكعب،

يتم استخدام مضختين على الأقل بمعدل إنتاج إجمالي لا يقل عن 130 متر مكعب في الساعة، مع الاحتفاظ بمضخة احتياطية (spare pump) في وضع الاستعداد (stand-by position)



تجهيز الموقع وتخطيط مرحلة الصب (Site Preparation and Stage Planning)

لكل صبة (pour) ، يتم إعداد خطة تفصيلية لمرحلة الصب (stage concrete planning) من قبل مهندس الموقع. تتضمن هذه الخطة جدولاً بكميات الخرسانة وتوزيعها وتوقيتها ومعدل الصب لكل مضخة وذراع صب، وعدد وموقع مضخات الشاحنات والمضخات الثابتة وأذرع الصب، وتحديد عدد شاحنات الخلط المطلوبة، ومعدات الهز والتشطيب، وعدد وأموقع أبراج الإضاءة، ومصادر الطاقة وتوزيعها، وتزويد المياه للتنظيف، والمعدات الاحتياطية، وتسلسل صب الخرسانة، وتخطيط الورديات بما في ذلك تخطيط فترات العمل والراحة، وتخطيط جميع إجراءات المعالجة.

التعليمات العامة (General Instructions)

سمك الطبقات (height of layers) أقل من 50 سم، وارتفاع سقوط الخرسانة الحرة (falling height) أقل من 1.5 متر، وقطر الهزاز الداخلي 65 مم، ونمط نقاط الغمر (pattern of immersion points) هو 50 سم × 50 سم.

على كل خرطوم ضخ، يعمل عاملان للحفاظ على الخرطوم في الموقع الصحيح وضمان ألا يتجاوز ارتفاع السقوط 1.5 متر. يقوم ثمانية عمال في كل موقع صب بدمك الخرسانة باستخدام أربعة هزازات داخلية على الأقل. يقوم عامل بغمز الهزاز في الخرسانة، وعامل آخر بالتعامل مع الكابلات وتشغيل وإيقاف الطاقة.

تُصب الخرسانة طبقة تلو الأخرى (layer by layer) يتم غمر الهزازات حوالي 10 إلى 15 سم داخل الطبقة التي تتحتها لضمان الترابط الجيد بين الطبقات. نمط نقاط الغمر هو 50 سم × 50 سم. في المناطق التي توجد فيها قوائم رأسية لعوازل المياه (waterstop upstands) أو بين القطع المضمنة، يتم استخدام هزازات بقطر صغير بين الشدات الخشبية (formwork) وعازل الماء.

معالجة الخرسانة (Curing of Concrete)

تبدأ إجراءات المعالجة فور الانتهاء من آخر طبقة خرسانية وتتبع تقدم عملية الصب. يتم تجهيز جميع المعدات والمواد اللازمة لنظام المعالجة قبل انتهاء الصب. يتم مد جميع الخراطيم، وتركيب واختبار مضخات تزويد المياه.

فترة المعالجة وفقاً للمواصفة 1-5.16.2.1 PTS clause هي كالتالي:

• لا تقل عن 14 يوماً متتاليًا من نوفمبر إلى أبريل.

• لا تقل عن 21 يوماً من مايو إلى أكتوبر شاملة.

يتم تطبيق ثلاث طرق للمعالجة:

- المعالجة المائية بالغمر (Water Curing by Flooding): تستخدم للأساسات الكتلية ذات الأسطح الأفقية. يتم عمل حاجز من المونة أو الخرسانة حول حواف الكتلة بارتفاع 5 سم، ثم يملأ الداخل بالمياه.
- المعالجة المائية بالرش (Water Curing by Sprinkling): يتم وضع مواسير مثقبة بحيث تبقى كامل سطح الصبة مبللة بشكل دائم. يتم معالجة المفاصل الرأسية بالرش المستمر.
- المعالجة بالتغطية (Curing by Coverage – Burlap and PVC Foil): تستخدم للأساسات الكتلية ذات الأسطح المائلة والمناطق الخاصة. تُغطى الخرسانة بخيش مبلل مسبقاً (burlap pre-wetted)، ثم تُغطى من فوق برقائق PVC، وتثبت الرقائق بأوزان لمنع تحركها بفعل الرياح.
- المعالجة بالأغشية (Membrane Curing): تستخدم للعناصر المرتفعة والأسطح الرأسية المشطوبة. يتم استخدام مركب معالجة (curing compound) معتمد من قبل صاحب العمل (Employer)، ويتم تطبيقه فور إزالة ألواح النماذج الخشبية الرأسية باستخدام نظام رش أو أسطوانات وفقاً لتوصيات الشركة المصنعة. يتم التحكم في السمك والتغطية الكاملة بصرياً ومن خلال استهلاك المادة.

الفصل الخامس أعمال الشدات (الفرم) للمنشآت المرتفعة

يهدف هذا البوست إلى تلخيص منهجية العمل الخاصة بإنشاء وتجهيز الأسطح الخرسانية الرأسية وفواصل الصب في المنشآت المرتفعة (Elevated Structures) بالمشروع، باستخدام أنظمة شدات (فرم) قياسية من نوع PERI أو SGB، مع أنظمة دعم وقوالب تصاعدية (Climbing Formwork).

الموارد والمواد المستخدمة: المعدات والمواد فتشمل نظام شدات قياسي من نوع PERI موديل (Vario مع كوابح (Brackets) من نوع SKS180، ونظام شدات قياسي من نوع SGB مكون من جنود MK II وكمرات (DU-AI S/T 150). كما تشمل المواد المستخدمة ألواحاً من الخشب المنشور بسمك 25 مم، وأبلكاش بسمك 21 مم، وشبكاً معدنياً موسعاً (Expanded Metal) من نوع 615، وفواصل شد (Tie Rods) بأنصاف مختلفة (عادة وبدون مونة)، ومواد عازلة للفصل (Form Release Agent)، وأسلاك ربط، بالإضافة إلى أبراج سلالم للوصول الآمن.

أولاً: نبذة سريعة عن نوعي الشدات

• PERI

منتج شركة ألمانية تعتبر من أكبر شركات أنظمة الشدات والسقالات في العالم، معروفة بالأنظمة الحديثة والـ Engineering العالي .

• منتج شركة SGB

شركة بريطانية قديمة ومعروفة في أنظمة الشدات والسقالات، وتستخدم بكثرة في مشاريع الشرق الأوسط.

PERI

فلسفة النظام

نظام هندسي متكامل
Modular System
كل عنصر مصمم
كجزء من نظام واحد

مميزات PERI

- خفيف الوزن
- تركيب سريع
- عدد عمال أقل
- نشطية خرسانية عالية
- عمر استخدام طويل

الفرق بين نظامي الشدات الخشبية PERI & SGB

SGB

فلسفة النظام

نظام تقليدي ثقيل
Heavy Duty System
يعتمد على القطع
التقليدية والمرونة
بالموقع

مميزات SGB

- مرونة عالية
- تناسب الأشكال غير المنتظمة
- تكلفة أولية أقل
- منوفر محلياً بسهولة
- قوي يتحمل الأحمال

نموذج لشدات بلاطة PERI

ألواح خشب
مغطاة بالفيلم
جائزات رئيسية (H20)
جائزات ثانوية
دعامات معدنية
قابلية للتعديل
رؤوس (Drop Head)
لتسهيل الفك الميمار

نموذج لشدات بلاطة SGB

ألواح خشب
جائزات خشب ثقيلة (Timber Beams)
عارضات خشب فرعية
دعامات معدنية ثقيلة
رؤوس تقليدية

شدات جدار PERI

ألواح حاظق (Tie)
دعامة شد مائلة
عنصة عمل
قشبياني ربط (Tie Rod)
كاثبات سريعة

شدات جدار SGB

ألواح خشب
عارض خشب أفقية
قوائم رأسية خشبية
دعامة شد مائلة
قضبان ربط
كاثبات تقليدية

دورة انتفيذ - PERI (Cycle)

دورة انتفيذ - SGB (Cycle)

مقارنة سريعة

العنصر	PERI	SGB
الوزن	أخف	أثقل
سرعة التركيب والفك	أسرع	أبطأ
عدد العمال	أقل	أكثر
جودة سطح الخرسانة	أعلى	جيدة
المرونة في الأشكال	أقل	أعلى
التكلفة الأولية	أعلى	أقل
العمر التشغيلي	طويل	متوسط
المشاريع المناسبة	المشاريع الضخمة والسريعة والأعمال التقليدية	المشاريع المتوسطة

أمثلة استخدام PERI

جسور وكباري
أبراج عالية
سدود ومحطات

أمثلة استخدام SGB

مباني سكنية
مشاريع متوسطة
أعمال بها تعديلات كثيرة

تصميم الشدات: تم تصميم الشدات والكوابح لتحمل ضغط خرساني مقداره 25 كيلو نيوتن/متر مربع، وبسرعة صب قصوى تبلغ 50 سم/ساعة للمنشآت المرتفعة. كما تم تحديد أقصى انحراف مسموح به للمواد المختلفة: 20 مم للشبك المعدني الموسع، 1 مم لألواح الأبلكاش، و3 مم للألواح الخشبية المنشورة.

إجراءات التجميع: يتم تجميع ألواح الشدات (Panels) على منصة خرسانية أو خشبية. بالنسبة لنظام PERI، تتكون الألواح من مرابط أفقية من الصلب (SRZ twin-channel) وأعمدة رأسية من خشب GL (GT 24) وواجهة من الأبلكاش أو الخشب المنشور. أما بالنسبة لنظام SGB، فتتكون الألواح من كمرات أفقية DU-AI S/T 150 وأعمدة رأسية (جنود) MK II، مع تثبيتها باستخدام مشابك عامة (Universal Clamps). يتم بعد ذلك تجهيز الألواح ورفعها باستخدام الرافعة لتثبيتها في موقعها.

عملية التسلق (Climbing) للشدة: تتم عملية رفع الشدات (Climbing) بعد وصول الخرسانة إلى مقاومة كافية لا تقل عن 15 ميغا باسكال لرفع الكوابح، وتصل إلى 25 ميغا باسكال قبل صب العنصر التالي رفع ألواح الشدات نفسها وتثبيتها على الكوابح. يختلف الإجراء قليلاً بين نظامي PERI و SGB،

حيث يستخدم نظام PERI دعامات دفع/سحب (Push Pull Props) لضبط الألواح، بينما يتم في نظام SGB تفكيك الألواح بالكامل وتخزينها أرضياً ثم رفعها مرة أخرى.

إجراءات الفك ومعالجة الفتحات: يتم فك الشدادات بعد وصول الخرسانة إلى مقاومة لا تقل عن 40% من مقاومة الضغط المميزة بعد 28 يوماً، ويتم التحقق من ذلك بواسطة المختبر من خلال فحص مكعبات الخرسانة المبكرة (Early Strength Cubes) التي تم أخذها من آخر شاحنة خرسانية وتخزينها ومعالجتها بنفس ظروف العنصر الخرساني

فواصل الصب: (Construction Joints) تظهر واجهة مفصل الصب بعد إزالة الشبك المعدني الموسع بخشونة ونظافة، وذلك دون الحاجة إلى أعمال إزميل أو تخشين إضافية، وفقاً لمتطلبات المواصفات الفنية. قبل صب العنصر المجاور، يتم تنظيف السطح جيداً باستخدام هواء عالي الضغط وترطيبه مسبقاً (Pre-wetting).

الفصل السادس: لقطع وثني حديد التسليح

يهدف هذا التقرير إلى تلخيص منهجية العمل المعتمدة لقطع وثني حديد التسليح في ساحة مركزية واحدة بالمشروع، لتغذية الأعمال الخرسانية

يتم تجميع أعمال قطع وثني حديد التسليح في ساحة مركزية واحدة (Centralised Site Yard)، بدلاً من توزيعها على عدة مواقع بهدف تحسين عملية الإنتاج والرقابة على الجودة، وتسهيل عملية التخزين والتوزيع، والاستخدام الأمثل للمعدات والعمالة المتخصصة. يتم بعد ذلك توزيع قضبان الحديد المقطوعة والمثنية حسب الطلب إلى مواقع الصب المختلفة في حفرة الإنشاءات.

المعدات والموارد البشرية: تم تجهيز الساحة المركزية بمجموعة متكاملة من المعدات الثقيلة ومعدات القطع الثني. ولأعمال المناولة والرفع، تم توفير ونش (Gantry Crane) بسعة 12 طناً، مزود بعارضة مغناطيسية (Magnetic Spreader Beam) للتعامل مع حزم القضبان الطويلة التي يتراوح طولها بين 12 و 18 متراً، بالإضافة إلى ونش برجى (Tower Crane) من نوع Liebherr 180/ECH لتغطية منطقة العمل.

أما لنقل الحديد المقطوع والمثني إلى مواقع الصب، فيتم استخدام جرار رئيسي (Head Tractor) مزود بـ 4 إلى 6 مقطورات خلفية. (Tail Trailers) أما معدات القطع والثني، فتتكون من ثلاث ماكينات قطع (Offmehrer) بموديلات C52 و C42 و C36، وثلاث ماكينات ثني (Offmehrer) بموديلات P52 و P42 و P36، وتتناسب قدرات هذه الماكينات مع أقطار الحديد حيث تصل إلى 40 مم و 32 مم و 25 مم على التوالي.

التخزين والتسليم إلى الموقع: تم تقسيم منطقة التخزين إلى أربع مناطق رئيسية: المنطقة 1 للهويس (Navigation Lock)، والمنطقة 2 للمفيض (Sluice Way -)، والمنطقة 3 لمحطة الكهرباء (Powerhouse)، والمنطقة 4 للأعمال المتنوعة.

الصحة والسلامة: يخضع جميع العاملين في أعمال قطع وثني الحديد لخطة الصحة والسلامة الخاصة بالمقاول، ويشترط عليهم ارتداء معدات الوقاية الشخصية اللازمة. (PPE) بشكل إضافي، يُطلب من العاملين في أعمال قطع وتنظيف الحديد، واستخدام ماكينات السنفرة (Grinding Machines) وإزميل الخرسانة، ارتداء القفازات الواقية ونظارات الأمان. كما يتم توفير إضاءة كافية للعمل في الورديات الليلية، وتجهيز جميع التوصيلات الكهربائية بمفاتيح قاطع التسرب الأرضي (GFCI) ، وإلزام جميع الأفراد بحضور جلسات التدريب على السلامة التي ينظمها المقاول.

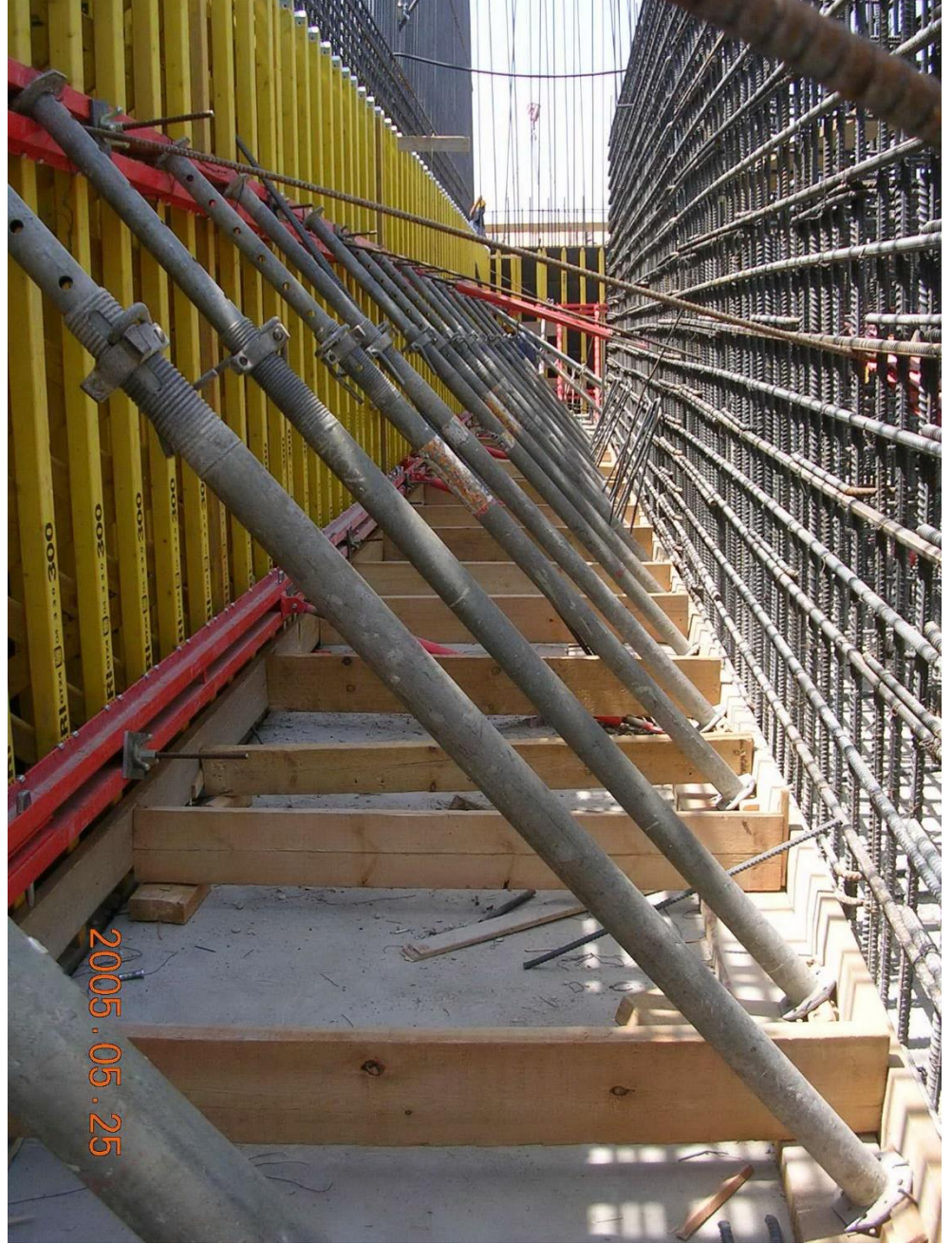












الفصل السابع: وضع حديد التسليح في الخرسانة القائمة

يهدف هذا البوست إلى تلخيص منهجية العمل القياسية لوضع أسياخ تسليح جديدة (أسياخ انتظار أو إضافات) في منشآت خرسانية قائمة (سبق صبها) في مشروع قناطر نجع حمادى الجديدة، وذلك لمعالجة حالات فقدان أو تلف أو سوء وضع أسياخ التسليح بعد تنفيذ العناصر الخرسانية الرئيسية.

نطاق العمل وأسباب الحاجة إليه: قد تحدث حاجة لوضع حديد تسليح جديد في خرسانة قائمة لأسباب متعددة، مثل تغيير متطلبات التصميم بعد التنفيذ، أو سوء وضع أسياخ الانتظار (Starter Bars) أو تلفها.

يهدف هذا الإجراء إلى توفير وسائل تثبيت كافية للتسليح الجديد في العناصر الخرسانية القائمة لضمان استمرارية وسلامة المنشأ. يتم تنفيذ هذه الأعمال تحت إشراف مهندسي ومشرفي الموقع، وبواسطة عمال مدربين وذوي خبرة في الحفر والحقن.

الطريقتان الرئيسيتان للتنفيذ : هناك طريقتين أساسيتين لتثبيت حديد التسليح الجديد، وتعتمد الطريقة المناسبة على عمق الفتحة المطلوبة وقطر السيخ:

1. **الحشو بمونة غير منكمشة (Non Shrink Grout) قائمة على الأسمنت:** تستخدم هذه الطريقة بشكل عام عندما يكون عمق الفتحة المحفورة كافياً لتحقيق طول التثبيت المطلوب.

2. **الحقن بمونة إيبوكسية (Epoxy based Mortar) من نوع: Hilti HIT RE 500** تستخدم هذه الطريقة عندما تكون الفتحة المحفورة غير عميقة بما يكفي للطريقة الأولى، حيث توفر قوة التصاق أعلى.

أعمال التحضير المشتركة (الحفر والتنظيف): قبل البدء بأي من الطريقتين، يتم تنظيف سطح الخرسانة القائمة جيداً. يتم حفر الفتحات باستخدام جهاز حفر صخري هوائي (Atlas Copco RH 571-5L) لفتحات يصل قطرها إلى 40 مم، أو باستخدام جهاز Hilti TE 76 للأقطار المختلفة. بشكل عام، يجب أن يكون قطر الفتحة أكبر بمقدار 5-10 مم من قطر سيخ التسليح. يتم تحديد عمق الفتحة بناءً على قطر السيخ ونظام التثبيت، ويجب ألا يقل عن طول التثبيت الأدنى المحدد في رسومات التسليح. بعد الحفر، يتم تنظيف الفتحات تماماً من الغبار باستخدام ضغط هواء عالي (جهاز كمبروسر Atlas Copco XA136) لضمان سطح خشن وخالي من الأتربة، وهو أمر ضروري للأداء الأمثل لعملية التثبيت، مع التأكد من أن الفتحات جافة تماماً قبل حقن المواد الإيبوكسية.

طريقة الحشو بالمونة الأسمنتية غير المنكمشة (Non Shrink Grout): يتم استخدام مواد معتمدة مثل Sikagrout 200 أو Sikagrout 214 أو Masterflow 524 M. يتم خلط المونة باستخدام مثقاب ذو مضرب خلط بسرعة تتراوح بين 300 و 400 دورة في الدقيقة، في وعاء سعة 30 لتراً. في حالات الطقس الحار، يجب تخزين أكياس المونة في الظل، وتظليل المنطقة المراد حقنها، واستخدام مياه مبردة للحصول على درجة حرارة مونة تتراوح بين 25 و 30 درجة مئوية. يتم ملء الفتحة المحفورة والنظيفة بمقدار ثلثي طولها بالمونة، ثم يتم إدخال سيخ التسليح الجديد بحذر. بعد ذلك، يتم معالجة المونة (Curing) بتغطية المناطق المكشوفة بخيش مبلل لعدة أيام.

طريقة الحقن بالمونة الإيبوكسية (Hilti HIT RE 500): تستخدم هذه الطريقة عندما تكون الفتحة المحفورة غير عميقة بما يكفي للطريقة الأولى. يتم استخدام مادة إيبوكسية معتمدة من نوع Hilti HIT RE 500 ، ويتم تخزينها في غرفة مكيفة الهواء. يتم حقن المادة باستخدام موزع خاص (Hilti HIT-MD 2000) مزود بخراطيش سعة 330 مل. يبدأ الحقن من قاع الفتحة (قاع البئر) لضمان ملئها بشكل صحيح، ويتم ملء حوالي ثلثي الفتحة بالمادة. يجب إدخال سيخ التسليح الجديد بحذر خلال مدة لا تزيد عن 20 دقيقة من

الحقن، وإزالة أي فائض من المادة. بعد ذلك، يجب ترك السيخ دون أي حمل لمدة تتراوح بين 4 و 8 ساعات حتى تكتسب المونة الإيبوكسية مقاومتها الكافية.

الفصل الثامن : قياس درجات الحرارة في صبات الخرسانة الكتلية

. يهدف هذا التقرير إلى تلخيص منهجية العمل المتبعة لقياس ومراقبة درجات الحرارة الناتجة عن حرارة الإماهة (Hydration Heat) في صبات الخرسانة الكتلية، والتي تعتبر من العناصر الحيوية لضمان جودة ومتانة المنشأ الخرساني الضخم.. تستمر عملية القياس لمدة تتراوح بين أسبوعين وثلاثة أسابيع لكل صبة. ولتحقيق ذلك، تم تجهيز الموقع بثلاثة أجهزة لتسجيل البيانات (Data Loggers) من نوع (mikromec multisens)، يتسع كل منها لـ 8 قنوات قياس منفصلة، مما يتيح مراقبة شاملة لتوزيع درجات الحرارة داخل الكتلة الخرسانية

إجراءات تركيب نقاط القياس: تم تحديد 8 نقاط قياس استراتيجية داخل كل صبة خرسانية، ويتم تثبيت أسلاك القياس (Measuring Wires) على حديد التسليح باستخدام مشابك معدنية (Clips) لضمان بقائها في أماكنها أثناء الصب. توزع نقاط القياس على النحو التالي: نقطتان في القلب (Core Temperature – Centre) لقياس الحرارة المركزية، ونقطة واحدة لدرجة الحرارة المحيطة (Ambient Temperature)، بالإضافة إلى نقاط على الجوانب (يسار، يمين، وجه الخرسانة السابق) على بعد 5 سم من السطح الخارجي، ونقطة في الأسفل على بعد 10 سم من قاع الصبة، وأخيراً نقطة في الأعلى على بعد 5-10 سم تحت السطح العلوي للخرسانة. يضمن هذا التوزيع الحصول على ملف حراري كامل (Thermal Profile) للصبة.

تسجيل البيانات وتكرار القياسات: يتم برمجة جهاز تسجيل البيانات (Data Logger) ليقوم تلقائياً بقراءة وتسجيل درجات الحرارة من جميع النقاط الثماني بشكل دوري كل ساعة. يمكن بعد ذلك طباعة هذه البيانات مباشرة إذا كانت الطابعة متاحة ومتصلة بالجهاز في الموقع، أو تحميلها على جهاز كمبيوتر (PC) لتحليلها وأرشفتها. تعمل أجهزة التسجيل الثلاثة بشكل مستمر لتوفير رؤية شاملة ودورية لدرجات الحرارة في مختلف صبات الخرسانة الكتلية بالمشروع. بعد الانتهاء من قياس صبة معينة، يتم اتخاذ قرار بشأن الصبة التالية التي سيتم قياسها بناءً على الأولويات والجدول الزمني للمشروع..

الفصل التاسع :إصلاح وتشطيب الخرسانة

يهدف هذا التقرير إلى تلخيص منهجية العمل القياسية لإصلاح وتشطيب جميع المنشآت الخرسانية في المشروع، وتحديد الإجراءات الواجب اتباعها لأنواع العيوب المختلفة لضمان الحصول على سطح خرساني سليم ومتين وذو مظهر مقبول.

نطاق العمل والإجراءات العامة: يغطي بيان الطريقة هذا جميع أعمال الإصلاح والتشطيب للخرسانة، بدءاً من الفتحات الناتجة عن قضبان الشد (Tie Holes) وفتحات التثبيت (Anchor Holes)، وصولاً إلى حالات الفراغات السطحية (Honeycombs) بمختلف أعماقها. تم التأكيد على أنه لا يجوز البدء في أي

أعمال إصلاح قبل قيام جهة العمل أو الاستشاري بفحص المنطقة المتضررة وتحديد نوع العيب. يتم إصدار طلب فحص (RFI) وفقاً لقوائم الفحص المعتمدة (Checklist) تمر جميع أعمال الإصلاح بأربع مراحل أساسية متتالية: تحديد نوع الإصلاح، ثم أعمال التحضير (Preparation)، ثم وضع الطبقة الرابطة أو البادئ (Primer/Bonding Coat)، ثم تطبيق مادة الإصلاح (Application)، وأخيراً المعالجة (Curing).

يتم تحديد قائمة بالمواد المعتمدة للاستخدام، وتشمل مواد لاصقة مثل Sika Latex، ومواد حقن غير منكمشة (Non Shrink Grout) مثل Sikagrout و Masterflow، على أن يتم استخدام المواد المعتمدة فقط وفقاً لتعليمات الشركات المصنعة

الفصل العاشر : إصلاح الشروخ الخرسانية في المناطق الأفقية باستخدام الراتنج الإيبوكسي

يهدف هذا التقرير إلى تلخيص منهجية العمل القياسية لإصلاح الشروخ في المناطق الأفقية من المنشآت الخرسانية في مشروع قناطر نجع حمادى الجديدة، باستخدام الراتنج الإيبوكسي منخفض اللزوجة.

ويتم تحديد الموارد اللازمة من عمالة ومعدات حسب كل حالة على حدة. المادة الأساسية المستخدمة هي الراتنج الإيبوكسي منخفض اللزوجة من نوع CONCRETE 1315 M، وهو مادة معتمدة فقط للاستخدام في هذا الغرض.

الإجراءات العامة والتحضير: بعد تحديد منطقة الإصلاح، يتم إخطار جهة العمل أو الاستشاري بوجود عيب خرساني (NCR) ويتضمن الخطوات المتسلسلة المقترحة للإصلاح، ولا يسمح بأي عمل قبل معاينة المنطقة من قبلهم. يتم إصدار طلب فحص (RFI) وفقاً لقائمة الفحص المعتمدة. تشترط الوثيقة أن يكون عمر الخرسانة المراد إصلاحها 28 يوماً على الأقل قبل حقن أو صب الإيبوكسي في الشروخ. تتضمن أعمال التحضير إزالة جميع الأوساخ من داخل الشروخ وتنظيفها جيداً باستخدام نفثات الهواء (Air Blasting)، ويتم توسيع فتحة الشرخ إذا لزم الأمر. بعد التنظيف، يتم إحاطة محيط الشرخ بمادة السيليكون (Silicon) كحاجز وقائي لمنع تسرب الإيبوكسي خارج المنطقة المراد إصلاحها.

خلط وتطبيق الإيبوكسي: يتم توريد الراتنج الإيبوكسي على شكل مكونين مسبوقين الوزن (قاعدة ومفاعل). يتم إضافة مكون المفاعل إلى القاعدة وخلطهما جيداً باستخدام مثقاب بطيء السرعة مزود بخلاط مناسب (Mixing Paddle)، ويستمر الخلط حتى يتجانس اللون. بعد أن يجف السيليكون ويتصلب، يتم التأكد من أن الشروخ نظيفة وجافة تماماً. يتم بعد ذلك صب الإيبوكسي المخلوط ببطء شديد داخل الشروخ، مع الاستمرار في الصب حتى تمتلئ الشروخ بالكامل. في اليوم التالي، يتم إزالة السيليكون، ثم يتم طحن (Grinding) المادة الزائدة (التي علت على سطح الخرسانة) حتى تصبح مستوية مع سطح الخرسانة المجاورة.

بالإصلاح، والتأكد من التنظيف الجيد للشروخ بالهواء المضغوط، والإحكام الجيد لحاجز السيليكون لمنع تسرب الإيبوكسي، مما يضمن إصلاحاً دائماً وفعالاً.

احد عشر: كميات الخرسانة المسلحة

اجمالي كميات الخرسانة المسلح 385,000 م مكعب

فترة التنفيذ الرئيسية من ديسمبر 2004 الى سبتمبر 2006

اعلى انتاج شهري اغسطس 2005 بمكعب حوالى 30,000 متر مكعب

كميات الحديد المستخدمة 47,750 طن

نسبة الحديد المتوسطة 124.5 كجم/ م مكعب

ثانى عشر: السلامة والصحة المهنية

وفي الختام التركيز على الضوابط الصارمة للصحة والسلامة المهنية وحماية البيئة؛ حيث يفرض على جميع العاملين الالتزام بخطة السلامة الخاصة بالشركة وارتداء مهمات الوقاية الشخصية (PPE) ، مع إلزام عمال صب الخرسانة بارتداء قفازات ونظارات واقية خاصة ، وتوفير إضاءة كافية للعمل الليلي، وتزويد المعدات الكهربائية بقواطع حماية من تسرب التيار (GFCI). كما تلزم المنهجية كافة الأنشطة باتباع نظام الإدارة البيئية المعتمد للمشروع للحفاظ على سلامة البيئة المحيط

Naga Hammadi Barrage
Amounts of concrete and reinforcement

30.05.2006

Structure	Reinforcement to	Concrete m3	Reinforcement Content kg/m3
Powerhouse			
Abutment Pier			
U/S-Part 1	442,9	4.025,0	110,0
Support Towers U/S-Part 1	8,0		
U/S-Part 2	217,8	2.180,0	99,9
Support Towers U/S-Part 2	1,9		
Axis 1-2/A-G	2.665,0	20.075,0	132,8
Support Towers Middle Part	37,9		
D/S-Part			
Foundation Slab	232,5	1.951,0	119,2
Support Towers D/S-Part	19,3		9,9
Walls and Slabs	639,5	4.629,0	138,2
Σ PH Abutment Pier	4.264,8	32.860,0	129,8
D/S-Slab	148,4	1.732,0	85,7
Unit 1 - 4			
Unit 1+2			
Foundation Slab	1.805,8	11.505,0	157,0
Support Towers Unit 1+2	78,4		6,8
Walls and Slabs	3.803,0	20.440,0	186,1
Σ Unit 1+2	5.687,2	31.945,0	178,0
Unit 3+4			
Foundation Slab	1.820,8	11.505,0	158,3
Support Towers Unit 3+4	78,4		6,8
Walls and Slabs	2.560,0	20.440,0	125,2
Σ Unit 3+4	4.459,2	31.945,0	139,6
Crane Beam Ext. + St.Chamber	70,4	480,0	146,7
Slulceway			
Intermediate Pier, U/S-Part	341,7	3.955,0	86,4
Intermediate Pier, Axis 6-8/A-H	3.135,7	22.785,0	137,6
Support Towers (Middle+U/S)	59,9		
Intermediate Pier, D/S-Part			
Foundation Slab	158,3	1.490,9	106,2
Support Towers D/S-Part	15,0		10,1
Walls and Slabs	412,4	2.959,2	139,4
Σ Intermediate Pier	4.123,0	31.190,1	132,2
Slulceway	4.558,9		
Foundation Slab		32.000,0	
Support Towers	332,9		10,4
Piers		20.620,0	
Σ Slulceway	4.891,8	52.620,0	93,0
Slulceway, D/S-Slab	816,2	8.940,0	91,3
Abutment Pier			
Axis 15-17/A-H	2.123,2	15.445,0	137,5
Support Towers	61,9		
Abutment Pier, D/S-Part			
Foundation Slab	101,4	880,0	115,2
Support Towers D/S-Part	8,5		9,7
Walls and Slabs	392,4	3.286,0	119,4
Σ SW Abutment Pier	2.687,4	19.611,0	137,0
Service Bridge	62,1	322,0	192,9
Main Gantry Crane Bridge	165,4	818,0	202,2
Navigation Lock			
U/S-Head, Axis K-L/19-22			
Support Towers	29,2		
Foundation Slab, Slabs, Walls	1.294,2	13.540,0	95,6
Σ U/S-Head	1.323,4	13.540,0	97,7
Middle Part, Axis L-S/19-22, L=25.5m			
Foundation Slab	2.116,8	26.026,4	81,3
Support Towers	161,9		6,2
Walls and Slabs	1.894,8	20.213,4	93,7
Σ Middle Part	4.173,5	46.239,8	90,3
D/S-Head			
Support Towers	80,7		1,4
Foundation Slab till +52.90 (58.40)	8.209,2	56.777,3	144,6
Walls and Slabs	3.686,7	29.971,0	123,0
Σ D/S-Head	11.976,6	86.748,3	138,1
Control- and Guard Tower	58,5	310,0	182,3
U/S - D/S additional Structures			
U/S - D/S Middle Pier	311,3	2.570,0	121,1
U/S - D/S Guide Wall	701,8	11.040,0	63,6
U/S Retaining Wall		460,0	
D/S Retaining Wall		2.680,0	
U/S - D/S Retaining Wall	271,5	3.140,0	86,5
Fender Mounting Posts (31pieces)	3,3	30,0	110,0
Σ add. Structures	1.287,9	16.780,0	76,8
Public Road Bridge (incl. Piers+Abutm.)	704,7	3.265,0	215,8
PH+SW-Guard Tower, Int.-Pier Stairc.Shift,	23,5	150,0	2,9
PH-Supply House at axis A/1			
Concrete Hatch Covers	11,7	170,0	68,8
SW-Aux.Bldg.,	16,1	145,0	111,0
Service Area (Cable Trench., Distr.Str.)	178,0	1.080,0	164,8
Capping Cut Off Wall			
COW PH-Abutment Pier (incl. vertical part):		376,7	
COW PH-Unit 1-4:		559,3	
COW SW-Int.-Pier:		210,9	
COW SW:		1.129,7	
COW SW-Abutm.-Pier:		173,8	
COW NL (incl. vertical part):		784,7	
Σ Capping COW	227,9	3.235,1	70,4
CLR	394,0		
Overall Summarizing:	47.749,7	384.126,3	124,3



اهد عشر : احتياطات الصحة والسلامة والبيئة :يولي بيان الطريقة اهتماماً كبيراً بمعايير السلامة والبيئة. فيما يتعلق بالصحة والسلامة، يُشترط على جميع العاملين في مناطق البناء ارتداء معدات الوقاية الشخصية اللازمة، وتوفير إضاءة كافية في حال وجود أعمال بنوبة ليلية، كما يجب على جميع الأفراد حضور جلسات التدريب على السلامة. أما فيما يخص حماية البيئة، فجميع أنشطة التحالف في الموقع، بما في ذلك منطقة الحفر، ملزمة بالامتثال لنظام الإدارة البيئية وخطة حماية البيئة الخاصة بالمشروع. يقوم قسم البيئة بالتحالف بإجراء تفتيشات بيئية منتظمة، وفي حال رصد أي ممارسة خاطئة أو عدم امتثال، يتم إصدار تقرير تفتيش بيئي (EIR) كما يشترط حضور جميع العاملين جلسات التوعية البيئية التي ينظمها المقاول

Part II, Particular Technical Specifications

SECTION 5 - CONCRETE

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5. CONCRETE

In this Section, Mass Concrete is defined in accordance with ACI 116R: "Any volume of concrete with dimensions large enough to require that measures be taken to cope with the generation of heat and attendant volume change to minimise cracking."

Instead of standards specified (ASTM, ACI, NFP) in this section the respective DIN standards can be applied.

5.1 Scope of Work

- 1) The work under this Section includes all labour, materials, equipment and services related to the concrete work to be carried out by the Contractor under this Contract.
- 2) Concrete work shall conform to all requirements of ACI 301, Specifications for Structural Concrete for Buildings, except as modified by ACI 207.1R, Mass Concrete for Dams and other Massive Structures and the Supplemental Requirements below.
- 3) The concrete work shall be performed to the dimensions as shown on the Construction Drawings prepared by or as otherwise directed by the Employer. Regarding the lifts, the Contractor shall indicate in sufficient time and detail to the Employer the scheme which he intends to follow, for the Employer's approval.
- 4) The Contractor shall cooperate with all other contractors and organisations related to the construction of Permanent Works whenever material or equipment is to be fixed to, or embedded in, the concrete structures.
- 5) The approval given by the Employer to the Contractor's plants and equipment or their operation, or to any construction methods, shall not relieve the Contractor of his full responsibility for the proper and safe execution of concrete work or the fulfilment of any obligations under this Contract.
- 6) The Contractor shall design the mixes which he proposes to use in the Works to achieve homogenous durable concrete which will have the required strength, low heat of hydration and other criteria specified and which will achieve acceptable workability and resistance to segregation during handling and placing. All testing of concrete and its constituent material, both before and during placing, will be the responsibility of the Contractor.
- 7) It is strongly recommended that the Contractor when developing his concrete design mix, orientates on experience made with similar projects in Upper Egypt. In these projects, a combination of locally available portland cement (OPC), slag cement produced by grinding locally produced OPC together with imported high blast furnace slag, and imported fly ash was successfully applied.

5.2 Submittals

- 1) Submittals listed herein are related to items, which require the consent of the Employer and are to be made by the Contractor before the corresponding work may be started.
- 2) Within 91 days from the date of issue of Notice to Commence Works at Site, but not less than 28 days before procuring or mobilising plant and equipment as shown on the accepted Construction Program, the Contractor shall submit to the Employer updated and detailed plans and descriptions, consistent with those submitted with his Tender and any subsequent amendments and additions agreed to by the Employer and the Contractor, of the following:
 - a) Aggregates Processing Plant: Description, flow diagrams and drawings in sufficient details to indicate layout, type and capacity of crushing, screening, washing, conveying and other aggregate processing and handling equipment as well as aggregate waste disposal.
 - b) Batching and Mixing Plants: Description, flow diagrams, and drawings of the plants. Interlocking systems, automation and recording facilities, size and capacity of each separate piece of equipment and showing clearly compliance with standards specified herein.
 - c) Concrete Cooling Plant: Details of refrigeration and/or ice plants and methods which the Contractor proposes to use to comply with concrete temperature requirements under special consideration of details as given in Section 5.14.2.
 - d) Transport and Placing of Concrete: Full details of the equipment and methods for transporting the concrete from the concrete plant to the final point of delivery, including numbers, type and capacity of transport vehicles and concrete pumps.
 - e) Sampling and Testing of Materials: List and details of equipment for sampling and testing, in accordance with the Quality Control Plan.
- 3) At least 119 days in advance of any concrete work being carried out at the site, as shown on the accepted Construction Program, the Contractor shall submit to the Employer the following information based on the results of the preliminary proportioning and trial mixes testing:
 - a) Cementitious materials manufacturers' identification and whether cementitious materials will be ordered in bulk or bags; if cement is to be obtained from more than one factory, the estimated amount of cement from each factory and the proposed schedule of shipment shall be stated. Details of transportation and storage facilities from the factory to, and including, the site. Copy of factory tests reports showing compliance with Quality Standards specified herein. Results of daily routine tests carried out at the cement factory for each type of cement to be used and for a period of one year preceding testing for proportioning of the trial mixes.
 - b) Source, method of delivery, and storage of water for concrete manufacture. Complete set of laboratory test reports showing compliance with Quality Standards specified herein.
 - c) Notification of any admixtures, fly ash and pozzolans which the Contractor proposes to use, manufacturers thereof, and information about the chemical

- names of the principal ingredients and the effects of under or over dosage;
Complete set of laboratory tests reports showing compliance with Quality Standards specified herein.
- d) Details of the materials for formwork and surface finishes, treatment of construction joints, and construction techniques which the Contractor proposes to use in order to achieve the required concrete surfaces and allowable tolerances.
 - e) Steel reinforcement supplier and manufacturer; if reinforcement is to be obtained from more than one factory, the estimated weight from each factory and the proposed schedule of shipment shall be stated; Complete set of mill test reports showing compliance with Quality Standards specified herein.
- 4) At least 28 days prior to procuring or dispatch to the site of the materials in question, the Contractor shall submit to the Employer the following:
- a) Details of the properties and performance, including the certified copies of laboratory tests reports showing compliance with Quality Standards specified herein for waterstops, expansion joint fillers, and joint sealing compounds along with material samples of the products.
 - b) Details of curing compounds including the certified copies of laboratory tests reports showing compliance with Quality Standards specified herein.
 - c) Details of epoxy mortar for concrete repair including the certified copies of laboratory tests reports showing compliance with Quality Standards specified herein.
- 5) At least 28 days prior to commencement of the corresponding work on a particular structure, as shown on the accepted Construction Program, the Contractor shall submit to the Employer drawings showing the location of any construction joints proposed by the Contractor which differ from those shown on the Construction Drawings, including formwork and reinforcement details.
- 6) During the performance of the concrete work, the Contractor shall record, in the language of the Contract, full details of all procedures for concreting. These records shall be made available to the Employer upon request, and shall include at least the following:
- a) Commencement and termination dates and times of concreting of the various parts of the structures.
 - b) Quantities and quality of aggregates and cement used, and the storage from which they were drawn.
 - c) Temperatures of air, water, cement, aggregates, and concrete as specified.
 - d) Meteorological conditions including the air humidity at the time of concreting.
 - e) Sampling and testing performed and summary of results.
 - f) Personnel employed during all stages of the concreting operation and name of the responsible inspector or foreman.

- g) Equipment used.
 - h) Instructions received from the Employer.
 - i) Any special materials or procedures employed.
- 7) The Employer reserves the right to request additional information to be included in the submitted documents.

5.3 Quality Standards

- 1) The publications listed below form part of these Specifications. Concrete materials, testing methods and procedures shall conform to the applicable standards of the American Society for Testing and Materials (ASTM) and to those contained in the US Bureau of Reclamation "Concrete Manual", or to equivalent applicable standards of DIN and publications of DAfSTb.

In this Specification, all or part of the standards and recommendations as listed in ACI 301 are applicable.

Specific Quality Standards regarding materials and practice that are applicable to the concrete works of the Project include but are not limited to the following:

ASTM: American Society for Testing and Materials	DIN: Deutsche Industrie Norm	Contents of Standard
ASTM C29	DIN 4226-3	Test Method for Unit Weight and Voids in Aggregates
ASTM C40	DIN 4226-3	Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C70	DIN 4226-3	Test Method for Surface Moisture in Fine Aggregate
ASTM C88	DIN 4226	Test Method for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C114	DIN EN 196-2	Methods for Chemical Analysis of Hydraulic Cement
ASTM C117	DIN 4226	Test Method for Material Finer than 0.075 mm Sieve in Mineral Aggregates by Washing
ASTM C125	DIN 4226-1/2 for concrete aggregates	Definition of Terms relating to Concrete and Concrete Aggregates
ASTM C127	DIN 4226	Test Method for Specific Gravity and Absorption of Coarse Aggregate

ASTM: American Society for Testing and Materials	DIN: Deutsche Industrie Norm	Contents of Standard
ASTM C128	DIN 4226	Test Method for Specific Gravity and Absorption of Fine Aggregates
ASTM C131	DIN 4226	Test Method for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	DIN 4226	Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C151	DIN 1164-1/2	Test Method for Autoclave Expansion of Portland Cement
ASTM C183	DIN EN 196-7	Method of Sampling and Acceptance of Hydraulic Cement
ASTM C185		Test Method for Air Content of Hydraulic Cement Mortars
ASTM C190		Test Method for Tensile Strength of Hydraulic Cement Mortars
ASTM C191	DIN EN 196-3	Test Method for Time of Setting of Hydraulic Cement by Vicat Needle
ASTM C204	DIN EN 196-6	Test Method for Fineness of Portland Cement by Air Permeability Apparatus
ASTM C227		Test Method for Potential Alkali Reactivity of Cement Aggregate Combination (mortar-bar method)
ASTM C260		Air-entraining Admixtures for Concrete
ASTM C311	Fly ash: DIN EN 450/ DIN EN 451; Pozzolans: DIN EN 196-5	Sampling and Testing Fly Ash or Natural Pozzolans for use as a Mineral Admixture in Portland Cement Concrete
ASTM C348		Test Method for Flexural Strength of Hydraulic Cement Mortars
ASTM C349		Test Method for Compressive Strength of Hydraulic Cement Mortars (Using Portions of Prisms broken in Flexure)
ASTM C360	DIN 1048-1	Test Method for Ball Penetration in Fresh Portland Cement Concrete

ASTM: American Society for Testing and Materials	DIN: Deutsche Industrie Norm	Contents of Standard
ASTM C403		Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
ASTM C451	DIN EN 196-3	Test Method for Early Stiffening of Portland Cement (paste method)
ASTM C469		Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C496		Test for Splitting Tensile Strength of Cylindrical Concrete Specimens
ASTM C535	DIN 4226-3	Test Method for Resistance to Degradation of Large-size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C566	DIN 4226-3	Test Method for Total Moisture Content of Aggregate by Drying
ASTM C596		Test Method for Drying Shrinkage of Mortar Containing Portland Cement
ASTM C618		Specifications for Fly Ash and Row or Calcinated Natural Pozzolans for use in Portland Cement Concrete,

ACI: American Concrete Institute	DIN: Deutsche Industrie Norm	Contents of Standard
ACI 207.1R	DBV-Merkblatt "Massenbeton für Staumauern"	Mass Concrete for Dams and Other Massive Structures
ACI 207.2R		Effect of Restraint, Volume Change, and Reinforcement on Cracking of Massive Concrete
ACI 121R	DIN 1045/ZTV-W	Quality Assurance Systems for Concrete Construction
ACI 201.2R	DIN 1045	Guide to Durable Concrete
ACI 210R		Erosion of Concrete in Hydraulic Structures
ACI 211.1		Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 214		Recommended Practice for Evaluation of Strength Test Results

ACI: American Concrete Institute	DIN: Deutsche Industrie Norm	Contents of Standard
ACI 221R	DIN 1045/ DIN 4226	Guide for Use of Normal Weight Aggregates in Concrete
ACI 223		Shrinkage-Compensating Concrete – Standard Practice
ACI 224R	DIN 1045/ZTV-W	Control of Cracking in Concrete Structures
ACI 224.3R	DIN 1045/ DIN 18197 E	Joints in Concrete Construction
ACI 225R	DIN 1045/ DIN 1164	Guide to the Selection and Use of Hydraulic Cements
ACI 304R	DIN 1045	Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
ACI 304.2R	DIN 1045	Placing Concrete by Pumping Methods
ACI 305R		Hot Weather Concreting
ACI 308	DIN 1045	Standard Practice for Curing Concrete
ACI 311.1R	DIN 1048/ DIN 1084	Manual of Concrete Inspection – SP2
ACI 347R	DIN 1045/ZTV-W	Guide to Formwork for Concrete
ACI 350.1R	DIN 1048	Testing Reinforced Structures for Watertightness
ACI 503.4		Standard Specification for Repairing Concrete with Epoxy Mortars
ACI 504R	DIN 18197 E	Guide to Sealing Joints in Concrete Structures
ACI 515.1R	DIN 181995-8/9	Use of Waterproofing and Other Barrier Systems for Concrete

PCA (Portland Cement Association): Design and Control of Concrete Mixtures Publication.

USACE CRD-C and Engineer Manuals. Department of the Army, Office of the Chief of Engineers, Washington, DC, 20314, USA

Concrete Plant Manufacturers Bureau, 900 Spring Street, Silver Springs, MD 20910, USA.

National Ready Mixed Concrete Association, 900 Spring Street, Silver Springs, MD 20910, USA.

Deutscher Ausschluß für Stahlbeton - DafStb, Scharrenstrasse 2-3, D-10178 Berlin, Germany.

- 2) In cases of conflict between the present Specifications and the above, the present Specifications shall take precedence.

5.4 Testing

5.4.1 Proportioning and Testing of Trial Mixes

5.4.1.1 General

- 1) At least 119 days prior to commencement of any concreting of Permanent Works, the Contractor shall start the testing of materials, develop the composition of concrete mixes and prepare trial mixes of each of the proposed concrete classes.

The Contractor shall proportion trial mixes in accordance with the recommendations of ACI 211.1 and ACI 207.1R: Mass Concrete for Dams and other Massive Structures and ACI 224R: Control of Cracking in Concrete Structures. Recommendations of ACI 305R: Hot Weather Concreting, when applicable, will also be taken into consideration. Trial mixes shall be prepared using the cement, water, aggregates and admixtures intended for the work and which conform to the requirements specified in this Section.

- 2) Proportioning of trial mixes shall include the determination of the following parameters:
 - Cement properties (selection of cement types and quantity)
 - Heat of hydration of the cementitious materials
 - Characteristics of aggregates
 - Mix water properties
 - Admixture properties
 - Proportion of aggregate ranges in the mix
 - Proportion of uncrushed to crushed aggregates
 - Cement dosage
 - Water-cement ratio, by weight
 - Workability of concrete mixes and allowable slump limits
 - Compressive and tensile strength
 - Entrained air

- Density
 - Watertightness
- 3) Proportioning tests shall be continued until the concrete mixes show to the satisfaction of the Employer the required strength, heat of hydration, workability, and density, without the use of excessive cement.

Testing of proposed trial mixes shall conform to ACI 214.

5.4.1.2 Cement

- 1) Selection and use of hydraulic cements shall comply with the recommendations of ACI 225. Manufacturer's Certification Reports shall be furnished. Cement shall be sampled and tested for strength and physical properties, for heat of hydration and for chemical analysis as defined in ASTM C150, or appropriate other standards (DIN) to be approved by the Consultant.

Testing will include but is not limited to the determination of the following characteristics:

Characteristic	Test Method
Flexural and compressive strength at 3, 7, 28 and 90 days	ASTM C348 and 349
Compressive strength at 90 days	ASTM C109
Initial and final setting time on pure paste	ASTM C 191
Le Chatelier stability	NF P 15-432
Shrinkage of cement mortar	ASTM C596
Chemical analysis	ASTM C114
Heat of hydration	NF P 15-436
Potential Alkali-reactivity of cement-aggregate	ASTM C227
Blaine's specific surface	ASTM C204

- 2) The Contractor shall obtain the cement samples for testing at the cement factory as the bins are being filled. Tests for false set shall be made on samples taken at the latest time prior to shipment.

- 3) The Contractor shall obtain from the manufacturer a Quality History established in accordance with ASTM C183 for a period of one year preceding testing for proportioning of the trial mixes. These results will be used to evaluate the variance of cement characteristics and eventually to adapt the safety margin to be taken into account in relation with the required average strength f_{cr} when designing the mixes.

5.4.1.3 Aggregates

- 1) Aggregates shall be sampled and tested as set out in ASTM C33. Tests listed in Table 5.1 of Section 5.21 will be carried out to support acceptance of the aggregates.
- 2) Tests shall be made on samples that are representative of the grading that will be used in the concrete and the aggregates shall be processed by the equipment proposed for the work.

5.4.1.4 Water

The suitability of the water for concrete shall be tested and the permissible amount of silt or suspended solids established, as specified.

5.4.1.5 Admixtures

- 1) Admixtures proposed by the Contractor shall be tested for their suitability with the cement and materials to be used in the Works and under proposed construction conditions.
- 2) Admixtures shall be sampled and tested as set out in ASTM C494, or by equivalent methods as approved by the Employer.
- 3) Air-entraining admixtures shall conform to ASTM C260 and shall be tested in accordance with ASTM C233.

5.4.1.6 Flyash

- 1) Flyash for use in concrete, shall be tested in accordance with ASTM C311.
- 2) These materials shall be tested in combination with the cement and aggregates to be used in the Works.

5.4.1.7 Concrete

- 1) Three or more trial batches, each 0.13 m^3 or more, with different water-cement ratios will be prepared for each of the design mixes specified, to produce a desired range of design strength.

- 2) The Contractor may propose to replace cement with pozzolan as cementitious material up to the values recommended in ACI 211.1. The ratio of pozzolan to cement replaced shall be approved by the Employer in accordance with test results. In these Specifications, cement refers also to the combination of cementitious materials (cement, slag, fly ash).
- 3) Concrete test cylinders shall be made and cured in accordance with ASTM C31. Twelve test cylinders shall be made from each batch, cured and tested in accordance with ASTM C192. Compressive strength test shall conform to ASTM C39. Three of the cylinders shall be tested for compressive strength from each group at 7 days age, three specimens in each group at 28 days age, and three specimens in each group at 90 days age. Other concrete tests shall be made as specified herein. The three remaining cylinders shall be used to determine the air-dry weight using the normal procedure described in ASTM C567. Concrete tests will include slump tests in accordance with ASTM 143, fresh unit weight yield and relative yield in accordance with ASTM C138, and air content in accordance with ASTM C231 for each trial batch at the time of preparing cylinders. The temperature of the laboratory air and of the concrete used in the trial batches shall be reported.
- 4) Tests shall be performed to determine the temperature development due to hydration within the concrete with all types of cementitious materials proposed for the Works. The temperature rise shall be recorded and corresponding diagrams be established. The objective is to design the mixes so that at least the requirements of clause 5.14 are met.
- 5) Splitting tensile strength of concrete shall be tested in accordance with ASTM C496. Cylindrical beams of concrete for testing shall be made and cured in accordance with ASTM C31.
- 6) Static modulus of elasticity and Poisson's ratio of concrete in compression shall be determined in accordance with ASTM C469.
- 7) Upon completion of the compressive tests of the design mixes, water cement ratio versus compressive strength curves shall be plotted. Copies of the compressive test reports and curves together with the recommended design of the mixes shall be forwarded to the Employer for acceptance.

5.4.2 Tests during the Performance of the Work

5.4.2.1 General

- 1) The Contractor shall carry out tests on materials and samples of concrete during the performance of work in order to provide Quality Control as specified for concrete production. The test program shall be as stipulated hereafter and the Contractor shall comply with the requirements and give all needed assistance in the performance of test program.

- 2) The proportions of material entering into the concrete may be changed in accordance with ACI 301 Section 3.11. New trial mixes shall be developed and the new mix may be used based on 7 days compressive strength after the compressive test report is issued and the mix design approved by the Employer.
- 3) All concrete produced for these tests shall be wasted or used for purposes other than inclusion in the structures.
- 4) The Contractor shall keep full records in the language of the Contract of all test results which shall be presented to the Employer upon request.
- 5) Should the Contractor wish to reduce his approved Quality Control Plan he shall notify the Employer of the changes required at least 14 days in advance.
- 6) Independently of the Contractor's Quality Control Plan the Employer will make control tests to the extent deemed necessary. The Contractor shall give the Employer all required assistance in sampling, handling, storage and transport of the specimens to be tested by the Employer.
- 7) The Contractor shall make any arrangements needed, or purchase new equipment, should the test results prove that changes in the aggregates or concrete plant are necessary to obtain the required concrete quality.

5.4.2.2 Cement

- 1) Cement shall be inspected for contamination and for lumps caused by moisture after arrival on the site.
- 2) When cement is delivered in bags, sufficient check weightings shall be made to assure that the bag weights conform with the stated weight. Packages that vary by more than 3% from the stated weight or when the average weight of 50 packages taken at random from any shipment is less than stated, the entire shipment, may be rejected by the Employer.
- 3) The delivery of each batch of cementitious material shall be accompanied by the Manufacturer's Certification Report in accordance with ASTM C150 and the continuation of the Quality History record established in accordance with ASTM C183 (Ref. 5.4.1.2 above).
- 4) Every 1,000 t, or alternatively every month if the monthly consumption is less than 1,000 t, or as directed by the Employer, the following control test shall be carried out, but will not be limited to:
 - Le Chatelier Stability,
 - flexural and compression strength at 3, 28 and 90 days,
 - initial and final setting time on pure paste according to ASTM C191 (Vicat Method): Initial set, minutes, minimum time, final set, hours, maximum time,
 - Blaine's specific surface.

- 5) Every 5,000 t, or alternatively every 3 months if the quarterly consumption is less than 5,000 t, or as directed by the Employer, the following control test shall be carried out, but will not be limited to:
 - heat of hydration (measured at 12 hours, 1, 2, 3, 5 and 7 days),
 - chemical analysis.
- 6) Should the cement factory be changed during execution of the work, testing as required in Section 5.4.1.2 shall be carried out.

5.4.2.3 Aggregates

Sampling and testing of aggregates in accordance with ASTM C33 shall be carried out at the frequency shown in Table 5.1 at the end of this Section.

At least four out of five consecutive tests for quality or grading shall comply with the corresponding requirements.

5.4.2.4 Water

No regular testing of water will be required after the sources of water have been established, unless required by the Employer or when the water becomes contaminated (e.g. turbid, muddy or salty) during execution of work.

Any water whose quality is questionable, or which is suspected of having detrimental amounts of sulfates, shall be chemically analysed in a specialised laboratory designated by the Employer.

5.4.2.5 Admixtures

- 1) Each shipment of admixtures to the site shall be sampled and tested in accordance with ASTM C494, C260, and ASTM C233, or equivalent methods as approved by the Employer.
- 2) Of each shipment to the site a sample of 1 kg (or 1 litre) shall be tested in the Contractor's laboratory.
- 3) Admixtures older than 12 months, from date of manufacture, shall be tested for deterioration.
- 4) Shipments of which the tested sample does not pass the criteria shall be rejected.

5.4.2.6 Flyash

When requested by the Employer, shipments of flyash shall be sampled on arrival on site and tested in accordance with ASTM C311.

5.4.2.7 Fresh Concrete

- 1) Concrete samples shall be obtained in accordance with ASTM C172 for sampling fresh concrete.
- 2) Moulds for casting concrete test specimens shall conform to the requirements of ASTM C470. Making and curing concrete test specimens shall be in accordance with ASTM C31. The standard specimen shall be the 152 x 305 mm cylinder when the maximum size of the coarse aggregate does not exceed 50 mm. When the maximum size of the coarse aggregate does exceed 50 mm, the diameter of the cylinder shall be at least three times the nominal maximum size of the coarse aggregate. Wet sieving to remove the aggregate larger than 50 mm and still use the standard cylinder will not be carried out unless specifically permitted by the Employer.
- 3) Compressive strength tests shall be made with a frequency of no less than:
 - one test for each unit volume less than 50 m³,
 - two tests for each unit volume ranging between 50 and 250 m³,
 - three tests for each unit volume greater than 250 m³ and three tests for each 300 m³ thereafter.

A unit volume of concrete being a structure or part thereof concreted in one pour and in a single day using only one concrete class.

For a strength test, three standard test cylinder specimens shall be made

As an average, one set of three specimens shall be tested at 7 days, one set at 28 days and one set at 90 days.

Once every 20th test for the plastic concrete diaphragm wall, static modulus of elasticity and Poisson's ratio shall be measured in accordance with ASTM C469.

Splitting tensile strength test in accordance with ASTM C496 shall be made with a frequency of no less than one test for each 1,000 m³ of concrete, or as directed by the Employer, for each class of concrete. Testing will be performed at 90 days.

- 4) Each test of 3 specimen cylinders shall be made from a single batch of concrete and then cured in accordance with ASTM C31 and Standard Practice ACI 308. Sets of 3 specimen cylinders shall be tested together for compressive strength in accordance with ASTM C39. The results of the tests shall be evaluated in accordance with ACI 214, Recommended Practice for Evaluation of Strength Test Results of Concrete. The criterion to be used, is that no more than 5 percent of the strength tests have values less than the specified strength. Whenever the evaluation of the results show that values are approaching the criterion limit, an adjustment shall be made on the mix design as specified. The Employer may require on-site tests such as sound velocity and coring of the parts of structures containing such marginal concrete and the Employer may then require reinforcement or demolishing and reconstruction at the expense of the Contractor.

- 5) Testing the compressive strength of concrete samples can alternatively be performed with cube test specimen (15 x 15 x 15 cm) applying test methods and frequencies in accordance with DIN 1048 and 1045, and applying statistical methods of evaluation as defined in DIN 1084.
- 6) The Contractor shall make slump tests in accordance with ASTM C143 on each concrete class throughout the duration of concreting work. Whenever a concreting operation is started, a slump test of the first two mixes shall be made for each class of concrete. Any concrete whose slump exceeds the allowable maximum determined at trial mix stage will be rejected.
- 7) For each batch tested: unit weight, yields, and air content according to ASTM C138 and ASTM C231 shall be tested and slump test (ASTM C143) done.
- 8) Typical test programs shall be proposed by the Contractor for the approval by the Employer.

5.4.2.8 Placed and Hardened Concrete

- 1) Where considered necessary by the Employer in case of potential deficiency of concrete in a completed part of structure, in-situ characteristics of placed concrete shall be tested in accordance with ASTM C42. The Contractor shall perform, as a minimum, fifty such tests on samples obtained from the structures. Samples found to be defective shall not be deemed to be included in this amount and shall be replaced by new ones by the Contractor.
- 2) Holes left after the cutting or core drilling shall be carefully filled with dry-pack mortar or epoxy mortar as directed by the Employer.
- 3) Specific gravity, absorption, and voids in hardened concrete shall be tested in accordance with ASTM C642, and compressive strength in accordance with ASTM C39.
- 4) The Contractor shall regularly test placed and hardened concrete using a "Schmidt Concrete Test Hammer". All test results will be recorded and given to the Employer on request.

5.4.2.9 Reinforcing Steel

Reinforcing steel shall be accompanied by a mill certificate and, when directed by the Employer, tested in a recognised laboratory to demonstrate compliance with ASTM A615 M or A185.

5.4.2.10 Curing Compounds

Curing compounds shall be tested in accordance with ASTM C156 to demonstrate compliance with ASTM C309 when directed by the Employer.

5.4.2.11 Aggregate Processing Plant and Concrete Plant

The performance of aggregate processing plant and concrete plant shall be tested by carrying out a trial concrete production run prior to any concreting of Permanent Works.

Monthly checks, or when requested by the Employer, of the concrete plant's weight-batching accuracy, including the accuracy of any admixture dispenser, shall be made by the Contractor in the presence of the Employer. When checked by standard weights and volumes its accuracy shall be within the limits given in ACI 304 (see clause 5.13.2, item 9) or as specified by the manufacturer and approved by the Employer.

5.4.2.12 Reporting of Laboratory Tests and Concrete related Specified Records

All results of tests carried out in relation with this section shall be reported to the Employer daily and shall be delivered in a bound form within three days after the end of each weekly reporting period. Each weekly report shall include the updating of control charts covering the entire period from the start of the construction through the current week. During periods of hot weather concreting, reports of temperature and specific procedures shall be made daily. These requirements do not relieve the Contractor of the obligation to report failures immediately.

5.4.2.13 Waterstops

- 1) All types of waterstops shall be tested in a recognised laboratory prior to shipment to the site. Test specimens shall be furnished by the manufacturer and the tests shall be carried out at the place of manufacture.
- 2) Waterstops shall be tested for their tensile strength, elongation, duration, water absorption, specific gravity, effect of alkali and impact resistance.

5.5 Concrete Materials

5.5.1 Cement

- 1) The Contractor shall supply and use cement (see clause 5.1, item 7), conforming to ASTM C150. The use of other cements or a blend thereof shall be subject to the approval of the Employer and in such case they shall be stored separately.
- 2) In addition to the individual requirements for each cementitious constituent, the blend shall comply with the requirements of Table 5.3 at the end of this Section.
- 3) Each consignment of cement delivered to the site shall be accompanied by a test certificate issued by the manufacturer in quadruplicate. The Employer will have the right to attend the sampling and testing at the manufacturer's plant at any time. If delivery is not directly from the manufacturer, the intermediate storage and delivery arrangements shall be subject to the approval of the Employer.

- 4) Cement which does not comply with ASTM C150, has been stored more than the specified period on the site or is damaged in consignment, handling or storage, shall be promptly removed from the site.
- 5) All facilities for transport and storage of cement shall be subject to approval by the Employer and shall be such that easy access for inspection is assured. Utilisation of different types of cementitious material requires separate storage facilities of sufficient capacity.
- 6) Bulk cement shall be transported from the factory to the site in adequately designed weather-tight wagons and trucks, or other means which ensures the cement will be protected from exposure to moisture. Immediately upon receipt at the site, cement shall be stored in dry, weather-tight and properly ventilated structures with adequate provisions for the prevention of absorption of moisture, and constructed in such a way that there will be no dead storage. The vents of cement bins and silos shall be equipped with dust collectors to reduce loss of cement during handling and inconvenience to the personnel.
- 7) Cement in bags shall be stored in weatherproof buildings with a raised, well-ventilated wooden floor, and placed so that each consignment can be segregated and used in order of its age. Bags shall not be stacked more than 1.5 m high. Cement shall not be stored outdoors, except for immediate use, and in such event shall be protected during storage and handling by waterproof covers and a raised floor. Unused cement shall be placed back in the storage buildings. All empty sacks shall be promptly disposed of by burning or means approved by the Employer.
- 8) Cement shall be used in approximately the chronological order in which it has been received at the site. Storage of cement shall be limited to 90 days in bags and 120 days in bulk. Cement that has been in storage for longer than these periods or which may have absorbed moisture shall not be used unless it has been re-tested by the Contractor and approved by the Employer. Cement that has become lumpy shall not be used. Cements from different factories or of different types and makes shall be stored separately.
- 9) The temperature of cement upon arrival at the site shall not exceed 60°C and, when entering the mixers shall be as low as possible and shall not exceed 50°C, unless otherwise approved.
- 10) The Contractor shall keep and make available to the Employer records of the date, quantity, and storage location of each delivery of cement and of the part of the Works in which it was used and shall provide facilities for checking the stock of cement. He shall also keep records of the daily use of cement and of the storage from which it was drawn.
- 11) The Contractor is solely responsible for the timely supply to the site of cement meeting all the requirements of these Specifications and the Works. Delays resulting from lack of suitable cement will not entitle the Contractor to any extension of time for the Completion of Works, or to any claims for additional payment resulting herefrom.

5.5.2 Flyash or Pozzolan

- 1) The Contractor shall propose the source, type, brand and manufacturer of flyash or pozzolan to be used as a cementitious material in concrete.
- 2) Flyash shall conform to the requirements of ASTM C618. In addition:
 - the loss on ignition shall be less than 5% when measured in accordance with ASTM C331,
 - Sulfate content shall be no more than 2.5% by mass when expressed as SO_3 ,
 - the reduction of mortar expansion shall be greater than 70%,
 - fineness shall be no more than 40% retained on a 45 μm sieve when tested in accordance with ASTM C430,
 - variation in specific gravity and fineness shall be not more than 5% from the average of previous test results,
 - autoclave expansion or contraction shall be not more than 0.8%,
 - the alkalis content as of Na_2O shall be not more than 1.5%.
- 3) Natural pozzolans shall meet the requirements of ASTM C618. The reduction of mortar expansion shall be greater than 80%.
- 4) When used in concrete, the percentage of cement, by weight, to be substituted by flyash or natural pozzolan shall not exceed the values recommended in ACI 211.1.

5.5.3 Aggregates

5.5.3.1 General

- 1) Aggregates shall consist of clean, hard, dense, durable and uncoated materials, and shall have a stable moisture content and grading when delivered to the batching plant. Aggregates shall not contain substances which may impair the quality of the concrete, attack reinforcing steel or reduce bond. The following substances are regarded as being harmful: loam, clay, pieces with large cavities, foam-like or vitreous pieces, and organic materials such as topsoil, roots, wood, coal, lignite, etc.

Deleterious substances are defined in ASTM C117, C142, C123, C40. In doubtful cases possible effects of harmful substances shall be established by tests.

- 2) The compressive strength of crushed aggregates, determined on cores with 50 mm diameter and 100 mm length, shall not be less than 120 MPa.

- 3) The apparent specific gravity shall not be less than 2.6 unless otherwise approved.
- 4) When tested in accordance with ASTM C33 and C88, coarse aggregates shall not show a loss in mass of more than 15% and fine aggregates not more than 10% (ASTM C33) after 5 cycles using magnesium sulfate.
- 5) The flakiness coefficient of aggregates larger than 4 mm, measured in accordance with NF P 18-561, shall be greater than 0.3.
- 6) Coarse and fine aggregates shall not have a water absorption of more than 2% when tested in accordance with ASTM C127 for coarse aggregates and ASTM C128 for fine aggregates.
- 7) Aggregates of more than 2.5 mm size shall have a Los Angeles of less than 40 when tested in accordance with ASTM C131 for fine aggregates and ASTM C535 for coarse aggregates.
- 8) The total chloride content arising from all ingredients in a mix including cement, water and admixtures shall not exceed the following limits, expressed as chloride ion and as a percentage of the mass of cement in the mix:
 - For any other reinforced concrete 0.3% in 95% of all test results providing no result is more than 0.5%.
 - The total sulfate content expressed as SO_3 of all the ingredients in a mix including cement, water and admixtures shall not exceed 4.0% of the mass of cement in the mix.
- 9) Aggregates shall be tested for Alkali-reactivity in accordance with NF P 18-542 and related NF standards.
- 10) The shape of the particles shall be generally spherical or cubical. All size classes of coarse and fine aggregates shall have a percent of flat and elongated particles lower than 25, as determined per USACE Handbook CRD-C 119. Rock which when broken does not satisfy this requirement will, regardless of the type of processing equipment used, not be approved for use in the production of aggregates.
- 11) The Contractor shall if required make provision for crushing and processing of material in accordance with recommendations contained in ACI 221 "Selection and Use of Aggregates for Concrete" to meet the gradation and other requirements of these Specifications, in order to obtain the total amount of aggregate required for concrete manufacture. Crushing, screening and washing operations, processing of aggregates, and blending of crushed and natural aggregates shall at all time be subject to the consent of the Employer.
- 12) The optimum proportion of crushed to natural aggregate shall be determined at trial mix stage. During the construction of the Works, the Contractor may use a greater proportion of crushed to natural aggregate than used in the approved trial mixes only with the consent of the Employer, providing that no claim for reimbursement for additional cement used will be made by the Contractor.
- 13) Natural and crushed aggregates shall be stockpiled and introduced in the mixer separately.

- 14) The handling, transporting, and stockpiling of aggregates shall be such that a minimum amount of fines shall result from breakage and abrasion of material due to improper handling. Excess in any fine or coarse aggregate sizes shall be disposed of in an approved manner. Materials shall be stockpiled in free-draining condition in silos or over a concrete floor. Specific location of stockpile area and methods of stockpiling of aggregates are subject to the Employer's approval.
- 15) Coarse and fine aggregates shall each be produced and stored on site, in at least two groups of gradation. These, as well as any deviation from the above requirement, shall be subject to approval by the Employer.

5.5.3.2 Source

- 1) Coarse and fine aggregates shall be produced from suitable material obtained from quarry and borrow areas described in Volume 4 - Information for Tenderers, or others proposed by the Contractor. Other sources may be designated or approved in the course of the work.
- 2) The Contractor shall carefully clear the area from which aggregates are to be produced of unsuitable materials and other objectionable matter. The area shall be operated so as not to detract from the usefulness of the area. All materials removed from the area and not used in the work shall be disposed of as directed.
- 3) Alternative sources proposed by the Contractor shall be subjected to approval by the Employer. The Contractor shall carry out tests to furnish satisfactory evidence that aggregates from all sources comply fully with the requirements of the Technical Specifications.
- 4) The approval of sources for aggregates shall not be construed as constituting the approval of all materials taken from the deposits. The Employer reserves the right to reject localised areas, strata, or channels within the approved areas and zones, should the material therein be unsatisfactory for use.

5.5.3.3 Fine Aggregate (Sand)

- 1) The term "fine aggregate" is used to designate aggregate in which the maximum size of particles correspond to the US standard size sieve No. 4 (4.75 mm).

- 2) Fine aggregates shall be well graded within the following limits:

Sieve Size (mm)	US Standard Sieve Designation (No.)	Percentage Passing by Weight	
		Pumped Concrete	Other Concrete
9.5	2	100	100
4.75	4	90 – 100	95 – 100
2.36	8	75 – 100	80 – 95
1.18	16	60 – 90	50 – 85
0.6	30	40 – 60	25 – 60
0.3	50	20 – 40	10 – 30
0.15	100	10 – 20	5 – 15
0.075	200	6 – 15	0 - 5

- 3) The fineness modulus of the fine aggregate shall be greater than 2.30 and less than the following values:
- 3.10 for natural sand,
 - 2.80 for processed fine aggregate,
 - between 3.10 and 2.80 proportional to the constituent materials when a blend of natural and processed sand is used.
- 4) The amount of deleterious substances in fine aggregate shall not exceed the limits given below:

	% by Weight
Organic matter	0%
Clay lumps and friable particles	1%
Material passing No. 200 sieve	2%
Lightweight material (as per ASTM 123)	2%
Total other deleterious substances	2%
Mica	3%

Nevertheless, the sum of the percentages of all deleterious substances shall not exceed 3% by weight.

- 5) Sand producing a colour darker than the standard set out in the test for organic impurities (ASTM C40) may be rejected.
- 6) Should the loss of weight of the portion retained on a No. 50 sieve, when subjected to five cycles of soundness test by use of sodium sulfate (ASTM C88), exceed 10% by weight, the fine aggregate may be rejected.
- 7) Fine aggregate, upon delivery to the batching plant, shall have a uniform and stable moisture content. The amount of moisture shall be less than 6% by weight, and shall not vary by more than 0.5% per hour.
- 8) Fine aggregate shall be kept clean at all times. The equivalent sand value (ESV) shall be greater than 75 when tested in accordance with ASTM C2419. Fine aggregate having an ESV lower than the specified value may be accepted if the blue value (BV) measured in accordance with NF P 18-592 is less than 1 g per 100 g of fines passing through the 80 micron sieve.
- 9) Fine aggregate shall be stored in such a way as to avoid segregation and entry of foreign materials.
- 10) The Contractor shall provide suitable drainage facilities to ensure that the sand delivered to the batching plant shall have uniform and stable moisture content. If required, two or three separate stockpiles shall be maintained, one for wet sand, possibly one for sand in the process of draining, and one in which the drained sand shall remain for a minimum 48 hours prior to the use.
- 11) The sand shall be stored at the site in bins or in stockpiles with concrete or timber floors and walls so as to avoid contamination or the risk of earth or clay being picked up when it is being used.
- 12) The Contractor shall maintain at all times a sufficient stored volume of fine aggregates to permit continuous placement of concrete.

5.5.3.4 Coarse Aggregate

- 1) The term "coarse aggregate" is used to designate aggregate which is retained on sieve No. 4 (4.75 mm). The coarse aggregate shall conform to ASTM C33. The coarse aggregate may be rejected if the specific gravity (bulk, saturated surface-dry basis) is less than 2.6, or if the absorption is greater than 2.5% when tested in accordance with ASTM C127.
- 2) The coarse aggregate shall be well graded from fine to coarse, and shall be separated into specific size groups. The gradation of the aggregate within each separated nominal size group as delivered to the mixer shall comply with ASTM C33, Table 2: Grading Requirements. Coarse aggregates shall be classified in a minimum of 3 grading classes defined by size number:
 - Size 7 (4.75 to 12.5 mm)
 - Size 5 (12.5 to 25 mm)
 - Size 3 (25 to 50 mm)

Grading requirements of ASTM C33, Table 2, will be modified according to the following table:

Sieve Size [mm]	US Standard Sieve	Percent Passing by Weight		
		Size 7	Size 5	Size 3
76.2	3			100
50.8	2			90 – 100
38.1	1 ½		100	35 – 65
25.4	1		90 – 100	3 – 10
19.1	¾	100	35 – 65	0 – 3
12.7	½	90 – 100	3 – 10	
9.5	3/8	35 – 65	0 – 3	
4.75	No. 4	3 – 10		
2.36	No. 8	0 – 3		

- 3) A combination of material from all size ranges shall be used for batching of all concrete with the exception of precast concrete elements and the second stage concrete for embedding of equipment in the blockouts.
- 4) The amount of deleterious substances in coarse aggregate shall not exceed the limits given below:

	% by Weight
Organic matter	0%
Clay lumps and friable particles	0.5%
Material passing No. 200 sieve	0.5%
Lightweight material	2%
Total of other deleterious substances	1%

Nevertheless, the sum of the percentages of all deleterious substances shall not exceed 3% by weight.

- 5) Coarse aggregates, upon delivery to the batching plant, shall have a uniform and stable moisture content.
- 6) The nominal maximum aggregate size in relation to the structure dimension shall not be larger than:
 - 1/5 of the narrowest dimension between the inner faces of forms
 - 3/4 of the minimum clear spacing between the reinforcing bars
 - 1/3 of the slab depth
- 7) Stockpiles of coarse aggregate shall be formed in such manner as to avoid the ingress of any foreign matter and to prevent segregation. Sufficient storage shall be maintained at all times to permit continuous placement of concrete.

5.5.4 Water

- 1) Water for washing aggregates and for mixing and curing of concrete, mortar, plaster, and grout shall be taken from an approved source and shall be clean, colourless, free from deleterious substances including salt, oil, alkaline or organic matters, sugar compounds, and shall not have brackish or saline taste. When shaken no permanent foam may form. The turbidity shall not exceed 2,000 ppm and the pH value shall be between 5.5 and 8.
- 2) Water shall meet the requirements of the USACE handbook CRD-C 400 and the total quantity of sulfates, expressed in sulfur anhydride, alkali-carbonates and bicarbonates shall not exceed 1 g/l. The suspended solids shall not exceed 2 g/l and the dissolved salts shall not exceed 500 ppm.

5.5.5 Admixtures

5.5.5.1 General

- 1) Admixtures shall be proposed by the Contractor and shall be used only with written approval of the Employer. Only admixtures that have been commercially used with satisfactory service in a similar type of concrete work shall be considered for approval. All admixtures shall be manufactured by a reputable company(ies), supported by a fully staffed technical service organisation and research group.
- 2) Admixtures shall be stored and handled as recommended by the manufacturer and so as to avoid contamination or damage to their properties by temperature or moisture changes or other influences.
- 3) The quantity of admixture used and the method of mixing shall be strictly in accordance with the manufacturer's printed instructions, or as required to produce specified results and approved by the Employer.

- 4) The Contractor shall be held liable for any damage and difficulties resulting from the selection and use of admixtures such as delay in concrete placing or damage to concrete during forms removal, and shall not be entitled to any time extension or claims resulting herefrom.

5.5.5.2 Accelerators

- 1) Only non-chloride accelerators meeting the requirements of ASTM C494, type C may be used if permitted by the Employer. The use of calcium chloride or other admixture in which chloride is added or serves as an active ingredient shall not be permitted.
- 2) Accelerators shall not be used in hot weather concreting.

5.5.5.3 Air-Entraining Admixtures

- 1) Air-entraining admixtures of the benzyl sulfonate derivative type, complying with ASTM C260 may be used. It shall be sampled at the source of supply and tested according to ASTM C233.
- 2) Air-entraining admixture shall be used to achieve a total air percentage by volume of concrete in accordance with the recommendations of ACI 301 and ACI 201 2R for mild exposure.

5.5.5.4 Water-Reducing, Set-Controlling Admixtures

- 1) Water-reducing, set-controlling admixtures shall conform to the requirements of ASTM C494, type A, D, E, F or G.
- 2) Nominal dosages for the admixtures will vary with changing climatic conditions at the site or other job conditions, and shall be approved by the Employer.

5.5.5.5 Nonshrink Agents for Grouts

- 1) The shrinkage of the cementitious mixtures shall be eliminated in grouts when required by adding to the water-cement mix an expanding admixture which reacts chemically with alkaline components of the cement and develops hydrogen gas (e.g. Intraplast of Sika or Conbex 100 from Fosroc), or by using a special nonshrink grout (e.g. Embeco 636 or 885 of Master Builders).
- 2) The material shall show no shrinkage (0.0%) and a maximum 1.0% expansion when tested in accordance with ASTM C827. A minimum 28 day compressive strength shall be 70 N/mm².
- 3) Nonshrink agents for grouts shall be tested for suitability and the Contractor shall assure that the manufacturer provides technical assistance upon request.

5.5.5.6 Combined Admixtures

Combined air-entraining, water-reducing admixtures shall be used where required to increase the watertightness and strength of the concrete (e.g. Plastocrete-DM of Sika).

5.6 Classification of Concrete

- 1) Concrete classes are referred to in the style: A/B

where: A = specified design strength (MPa)

 B = maximum aggregate size (mm)

The Specified Design Strength is based on 90-day tests with not more than 5% of tests falling below the Specified Design Strength.

- 2) Concrete in contact with steel reinforcement or steel liners shall not contain less than 240 kg of cement per cubic meter of concrete, to ensure sufficient alkalinity for corrosion protection.
- 3) Concrete mixes with the nominal compressive strengths and maximum aggregates sizes which shall be required for the construction of the Permanent Works are indicated in Table 5.2 at the end of this Section. These typical applications for the use of the different classes of concrete are for guidance only. The class of concrete required to be used in any specific location shall be as shown on the Construction Drawings, or as directed by the Employer.

5.7 Steel Reinforcement

5.7.1 General

The Contractor shall furnish, fabricate, and install all reinforcement steel as shown on the detailed reinforcement drawings and bar lists to be prepared by the Employer on the basis of the Contractor lift drawings. The work shall further include the furnishing and installation of all tie wires, clips, supports, chairs, spacers, and other appurtenances necessary to produce finished concrete structures. Steel reinforcement shall comply with the requirements of ACI 439.4R.

5.7.2 Quality Requirements

- 1) Reinforcing bars shall conform to ASTM A615 M requirements for deformed billet-steel of the grade shown on the drawings. Alternatively, reinforcing bars complying with the requirements of Egyptian Standard ES 262 may be used. Where shown on the drawings plain billet-steel bars shall be used.
- 2) Wire for tying reinforcement shall be smooth wire conforming to ASTM A82.
- 3) Welded wire fabric for in-situ or shotcrete reinforcement shall be made from electrically welded smooth wire and shall conform to the requirements of ASTM A185. Alternatively, welded wire fabric shall comply with the requirements of Egyptian Standard ES 1618.

5.7.3 Storage

- 1) Reinforcement shall be stored at the site and separated into the various sizes in such a manner that it is not contaminated with deleterious matter. Reinforcement supplied by different manufacturers shall be stored separately.
- 2) Reinforcement fabric supplied in rolls shall be straightened into flat sheets before being stored.

5.7.4 Cutting and Bending

- 1) Steel bars shall be accurately cut and bent to the dimensions and shapes as shown on the bar lists.
- 2) Warm-bending will only be permitted when adequate precautions are taken to comply with the corresponding direction issued by the steel manufacturer for such bending.
- 3) Temporary bending and subsequent straightening of bars partially embedded in concrete shall not be permitted, except when shown on the Construction Drawings or with the written approval of the Employer.
- 4) Should the necessity of welding of reinforcement arise, the provisions of the American Welding Society "Reinforcing Steel Welding Code" (AWS D12.1) shall apply.

5.7.5 Splicing

- 1) Reinforcement bars, other than tie bars, shall not be spliced at points other than those shown on the reinforcement drawings without the consent of the Employer. On occasions when it becomes necessary to alter the position of such splices, the new position and the type of splice shall be subject to the written approval of the Employer.
- 2) Where mechanical connections are proposed by the Contractor and approved by the Employer, they shall comply with the requirements of ACI 439.3R.

5.7.6 Placing

- 1) Reinforcing steel, before being positioned, shall be free from loose mill and rust scale, and from any coating that may destroy or reduce the bond between the steel and concrete.
- 2) As a rule, reinforcement from the same source shall be used in any individual structure. Using reinforcing bars proceeding from different mills for the same structure will be subject of the approval by the Employer.
- 3) Reinforcing steel shall be accurately positioned and secured against displacement by using ties made of annealed iron wire of not less than No. 16 gage, dobies, or suitable clips at intersection.

- 4) The metal chairs, bar spacer and similar reinforcement support devices that touch the forms shall be galvanised or shall have plastic tips at the point where the support device touches the forms.
- 5) The bottom layer of reinforcing steel in slabs on the ground shall be supported by means of precast concrete blocks (dobies). The concrete blocks shall have a horizontal surface approximately 7x10 cm and be of concrete quality at least equivalent to that which is to be placed. The upper layer of reinforcement in slabs on ground and all other slabs and in beams shall be supported by means of metal chairs. In all cases, sufficient supports for horizontal reinforcement shall be used so that there will be no sagging of the bars.
- 6) After all reinforcement is inspected in place and other requirements prior to concrete placement accepted, the Employer will issue a concrete permit to the Contractor for each single pour. Concrete placed in violation of this provision may be rejected and removal required.

5.7.7 Concrete Cover of the Reinforcement

The cover of the reinforcement shall be as indicated below or as shown on the Construction Drawings:

In-situ concrete:	
Bottom of foundations and footings	100 mm
Concrete cast directly against soil and being permanently exposed to it	75 mm
Formed concrete permanently exposed to backfill or water	50 mm
Outside exposure	40 mm
Inside exposure	30 mm
Precast concrete:	
Outside exposure	40 mm
Inside exposure	30 mm

5.8 Surface Finishes

5.8.1 General

- 1) The quality of the surface finish shall be as described in Sections 5.8.2 and 5.8.3. It shall be free from areas of honeycombs, segregation, loss of cement or fine material, from damage due to stripping of forms, from bolt holes, abrupt irregularities caused by movement of forms or components, loose knots and similar features and bulges or depressions in the general plane of the surface.

- 2) Only one type (quality) of formwork shall be used for all parts of a concrete structure which is visible from any direction.
- 3) The classes of finish shall be as shown on the Construction Drawings or as directed by the Employer.

5.8.2 Formed Surfaces

The classes of finish for formed surfaces are designated by the use of symbol F and the shape of the formwork panels required for concrete work shall be either plane (F1, F2 and F3) or curved (F1C, F2C and F3C).

- a) Finish F1, F1C: This finish shall be for surface concealed from view, including surface upon or against which backfill or concrete is to be placed, formed surfaces of expansion and contraction joints, and blockouts for equipment embedding or other parts which are to be built in. It may be obtained by the use of formwork or moulds of closely-jointed rough sawn boards. The surfaces will be imprinted with the grain of the sawn boards and their joints. Small blemishes caused by entrapped air or water may be expected, but the surface shall be free from voids, honeycombs, or other large blemishes. The surfaces require no treatment after formwork removal, with the exception of the filling of form-tie holes, correction of surface depressions deeper than 3 cm, the repair of defective concrete and curing as specified.
- b) Finish F2, F2C: This finish shall generally be for surfaces exposed to view. It is achieved by the use of properly designed forms of closely-jointed wrought boards. The surfaces will be imprinted with the slight grain of the wrought boards and their joints. Alternatively, steel or other suitable material may be used for the forms. Fascia boards consisting of 25x25 mm timber strips shall be fixed to the tops of forms to ensure the formation of straight and even horizontal construction joints. After removal of forms, the surface shall be improved by carefully removing all fins and other projections, thoroughly washing down, and then filling the most noticeable surface blemishes using methods described hereafter in "Repair of Defective Concrete". Form-tie holes shall be filled, and all voids, honeycombs, and other defective concrete repaired before curing as specified. When filling holes and repairing defective areas, every effort shall be made to match the colour of the concrete. The use of release agents which may permanently stain or discolour the finished surface will not be permitted.
- c) Finish F3, F3C: This finish shall be for surfaces in contact with flowing water where cavitation, headloss or erosion are of concern. The standard of finish required is similar to a F2 finish, but with no surface bubbles or holes larger than 3 mm diameter allowed, and with more stringent tolerance requirements measured along a line parallel and transverse to the direction of flow. Variations in concrete colour as a result of concrete repairs or staining due to release agents will be allowed. Fascia boards will not be required.

5.8.3 Unformed Surfaces

- 1) The classes of finish for unformed concrete surfaces are designated by the use of symbol U:
 - a) Finish U1 (screeded finish): This finish shall be applied to unformed surfaces that will be covered by fill material or concrete. Finishing operations shall consist of sufficient levelling and screeding to produce even, uniform surfaces. Surface irregularities shall not exceed those specified for Finish F1. This finish is also the first stage of finishes U2 and U3.
 - b) Finish U2 (floated finish): This finish applies to unformed surfaces not permanently concealed by fill material or concrete. Finishing operations shall consist of sufficient levelling and screeding to produce even surfaces in which the surface irregularities shall not exceed those specified for Finish F2. Floating with hand or power driven equipment shall be started as soon as the screeded surface has stiffened sufficiently, to produce a surface that is free from screed marks and is uniform in colour and texture. This finish is also the second stage of finish U3. If finish U3 is to be applied, floating shall be performed until a small amount of mortar without excess water is brought to the surface, so as to permit effective trowelling.
 - c) Finish U3 (steel trowelled finish): This finish shall be for surfaces in contact with flowing water where cavitation, headloss or erosion are of concern, as well as inside floors of buildings except where a bonded concrete finish or tile floor is foreseen. The standard of this finish is similar to U2, but with more stringent tolerance requirements parallel and transverse to the direction of flow. Steel trowelling shall start when the floated surface has hardened sufficient to prevent an excess of fine material from being drawn to the surface. It shall be performed with a firm pressure that will produce a dense, uniform surface free of blemish, ripples, and trowel marks.
- 2) Interior surfaces shall be sloped for drainage where shown on the Construction Drawings. Exterior surfaces, which will be exposed to the weather, shall be sloped for drainage even if there is no such indication on the Construction Drawings. In such case the slope shall be at least 2% but not exceed 3%.
- 3) The passageways of the service bridge, or where shown on the Construction Drawings shall receive U2 finish with additional broom finish. This shall be applied when the water sheen has practically disappeared. The broom shall be drawn transversely across the surface with adjacent strokes slightly overlapping. This work shall be completed before the concrete is in such condition that the surface will be torn or unduly roughened by the broom. The finished surface shall have an uniform appearance and shall be free from corrugations exceeding 3 mm in depth.

5.9 Tolerances

5.9.1 Concrete

- 1) Concrete surface irregularities caused by the roughness of the formwork facing or by inaccurately aligned joints between the formwork panels shall not exceed the following tolerances:

Specified Finish	Permissible Irregularities	
	Abrupt	Gradual
F1, F1C, U1	10 mm	20 mm
F2, F2C, U2	5 mm	10 mm
F3, F3C, U3		
a) Offset parallel to flow direction	5 mm	10 mm
b) Offset perpendicular to flow direction	3 mm	6 mm

- 2) Abrupt irregularities are offsets caused by displaced or misplaced form sheathing or lining or form sections, or by loose knots in forms or otherwise defective form lumber. They shall be tested by direct measurements.
- 3) Gradual irregularities are all other irregularities and shall be tested by a 2 m long template. The templates will be a straight edge for plane surfaces or a "shaped" template for curved or warped surfaces.
- 4) Further limitation for allowable abrupt irregularities for surfaces of structures with high velocity water flow shall be as follows if not otherwise shown on the Construction Drawings:
 - Abrupt irregularities parallel to the flow direction shall be eliminated completely by grinding to bevel of 1 to 20 ratio of height to length.
 - Abrupt irregularities transverse to the flow direction shall be eliminated completely by grinding to bevel of 1 to 50 ratio of height to length.
- 5) Deviations of concrete structure outlines from the lines and grades shown on the Construction Drawings shall not exceed 20 mm.
- 6) Variations in thickness of slab, columns and walls shall be within the limits -5 mm and +10 mm.
- 7) The Contractor shall repair hardened concrete which is not within specified tolerances as stipulated in "Repair of Defective Concrete" (Section 5.17). Such repair shall, however, be done only after consultation with the Employer and after his consent.

- 8) Concrete surface which may be in contact with high velocity flow shall be, without exception, brought within the specified tolerances. Grinding shall be limited in depth so that no aggregate particles remain exposed more than 2 mm in cross section at the finished surface. Where grinding would cause exposure of aggregate greater than the above limit, concrete shall be removed from the area affected and replaced by new concrete.

5.9.2 Reinforcement

- 1) The minimum centre-to-centre distance between parallel bars shall be as shown on the approved reinforcement drawings, with a tolerance of 20 mm.
- 2) In placing reinforcement steel, the tolerance from indicated protective cover shall be:
 - for 50 mm cover and less: 5 mm
 - for 75 mm cover and more: 10 mm

5.10 Formwork

5.10.1 Design

- 1) The Contractor shall assume full responsibility for the adequate design of all formwork, false work, and all accessories. Formwork shall comply with the requirements of ACI 347R.
- 2) The Contractor shall design formwork and false work to withstand at least the following loads unless agreed by the Employer:
 - The dead load of the concrete plus embedded items if any,
 - a live load of 2.5 kN/m^2 on the entire area of horizontal formwork or the load of a concreting bucket full of concrete, whichever introduces the greater stress,
 - horizontal wind forces of 0.9 kN/m^2 ,
 - pressure of fresh concrete computed as the smaller of the following two values:
 - $P(t/\text{m}^2) = h(\text{m}) \times 2.4$ where h is the head of fresh concrete,
 - $P(t/\text{m}^2) = a + bV$ where $V(\text{m/h})$ is the rate of rise for deposit of fresh concrete.

The values of a and b are given in the table below:

Temperature T of concrete when deposited	Rate of rise V (m/h)			
	V < 2 m/h		V > 2 m/h	
	a	b	a	b
T < 5°C	2	1.25	4.1	0.2
5°C < T < 25°C	2	1.00	3.6	0.2
T > 25°C	2	0.85	3.3	0.2

5.10.2 Workmanship

- 1) All forms shall be true to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and consolidating the concrete.
- 2) Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Forms shall be tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete.
- 3) Any forms which in the opinion of the Employer are unsafe or inadequate in any respect may, at any time, be rejected and the Contractor shall promptly remove the rejected forms from the Works and replace them.
- 4) An adequate number of temporary clean-out holes or short pipes shall be provided in the forms to secure the draining of washwater.
- 5) All exposed finished edges of concrete shall be chamfered 20 mm (at 1:1) unless otherwise shown on the Construction Drawings.
- 6) When a second lift is placed on hardened concrete, the number, location and tightening of ties at the top of the old lift and bottom of the new one shall be such as to prevent any damage to concrete. The form of a new lift shall overlap the hardened concrete by at least 10 cm to prevent abrupt irregularities.
- 7) Forms for sloping concrete surfaces shall permit their placing board-by-board or panel-by-panel immediately ahead of concrete placement so as to enable access for placing, vibration, and inspection of the concrete.

5.10.3 Materials

- 1) Materials used for form sheathing and lining shall be of wood, steel, or plywood.
- 2) Forms for concrete surfaces exposed to flowing water shall be lined with sanded, uncoated, plywood veneer. Steel or impermeable plastic liners will not be permitted.
- 3) Except as expressly approved by the Employer, all timber brought to the site for use as forms, shoring or bracing shall be new material. Plywood for use as form shall be mill-oiled and edge-sealed.
- 4) Rough sawn boards may be used only for the lowest grade (F1) of surface finish.
- 5) Where directed, expanded metal fixed to the formwork shall be used in vertical construction joints.

5.10.4 Form Ties

- 1) The type, number and positions of internal formwork supports and ties shall be subject to the approval of the Employer.
- 2) The whole or part of such formwork supports and ties shall be removed without damage to the concrete so as to leave no part embedded nearer the surface of the concrete than the designed cover of the reinforcement or 50 mm in the case of unreinforced concrete. Only metal portions of formwork supports and ties shall be allowed to remain in place.
- 3) Through bolts will not be permitted in water retaining walls.
- 4) Holes left after the removal of supports and ties shall be filled as described hereafter in "Repair of Defective Concrete", and shall be finished off neatly to the standard of the concrete surface. Such filling shall be adequately cured.

5.10.5 Care of Formwork

- 1) Forms shall be maintained at all times in good condition, particularly as to size, shape, strength, rigidity, tightness and smoothness of the surface.
- 2) All timber forms shall be given a preliminary oil treatment by the manufacturer or shall be oiled by the Contractor at least 14 days in advance of their use.
- 3) The surface of the forms shall be free from encrustation of mortar, grout, or other foreign matter at the time of concrete placement.
- 4) Before use, the forms shall be thoroughly cleaned and treated with a non-staining mineral oil or other lubricant approved by the Employer. Any excess lubricant shall be removed before placing the concrete. Care shall be exercised in keeping oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

- 5) Forms may be reused provided that they are in good condition, and that the required concrete form and finish may be achieved with their use. The Employer will, at any time, have the right to reject formwork which he considers to be no longer fit for such use.

5.10.6 Removal of Formwork

- 1) Removal of forms shall be performed with care to avoid damage to the concrete and as soon as permissible in order to avoid delay in curing and repair of surface imperfections. Forms shall not be removed without the consent of the Employer.
- 2) Forms may only be removed after the concrete has attained sufficient strength to prevent damage to concrete. Damaged concrete shall be repaired or treated by the Contractor as soon as possible, but not before the Employer has inspected such damage and agreed to the remedial works.
- 3) The minimum period before the removal of formwork shall be in accordance with the following table:

Type of Formwork	Days	Percentage of 28-Day Compressive Strength
Vertical formwork to columns, walls and large beams	2	40%
Soffit formwork to slab	7	70%
Props to slabs	12	85%
Soffit formwork to beams	10	80%
Props to beams	14	90%

- 4) The minimum period in days are only indicative. The governing rule to be observed is the 28-day compressive strength, which shall be determined by the cylinder test in addition to those required by the provisions as described in Section 5.4.2, "Tests during the Performance of the Work". When fixing the minimum period for formwork removal, the shrinkage and creep of the concrete shall be taken into consideration.

5.11 Joints in Concrete Structures

5.11.1 Construction Joints

5.11.1.1 General

- a) Concreting shall be carried out continuously up to the construction joints, the arrangement and positions of which shall be as shown on the Construction Drawings, or as approved by the Employer. Also, whenever concreting is forced to cease and placed concrete has become so hard that it does not permit the entry of a vibrator, a new construction joint shall be formed conforming to these Specifications.
- b) The position of certain construction joints shown on the Construction Drawings as mandatory shall not be altered. The Contractor may propose for approval different locations of other construction joints for reasons of concrete placement. Necessary rearrangement of steel reinforcement arising from such modifications shall be to the Contractor's debit.
- c) Construction joints shall be approximately horizontal or vertical. The joints shall appear as straight lines, produced by a board fixed to the formwork, at exposed faces.
- d) The surface of construction joints upon or against which new concrete is to be placed and to which new concrete is to adhere shall be clean, rough, and free of water when covered with fresh concrete. The laitance, loose or defective concrete and foreign material shall be removed from the surface of existing concrete. The previous concrete lift shall be saturated by water for approximately 24 hours, but shall be surface dry when the successive lift is placed.
- e) For horizontal construction joints, the surface of the hardened concrete shall be scabbed (chiselled) and all loose material shall be removed. Before placing new concrete, the surface shall be thoroughly cleaned with air-water jet, to remove all laitance, scum and foreign matter.
- f) For vertical construction joints, formwork shall prevent the loss of fine material from the concrete after placing. After removal of the formwork, the fresh concrete surface shall be scabbed (chiselled), and honeycombs - if any - be completely removed. Before placing new concrete, the surface shall be thoroughly cleaned by air-water jet.
- g) If the Contractor wishes to essentially deviate from the above, he shall submit a detailed description of the methods applied in preparation of the surface of construction joints, for approval by the Employer.
- h) Water used in cutting, washing and rinsing of concrete surfaces shall not cause stain, discolouring or affect exposed surfaces of the structures.
- i) Where indicated on the Construction Drawings, construction joints will be formed with central shear keys. The Contractor's proposed method for forming such keys shall be subject to the approval by the Employer.

- j) Steel sheet waterstop 40 cm wide and 3 mm thick shall be placed at all construction joints which are required to be watertight except in places where elastomere waterstops for vertical construction joints are approved by the Employer. Steel sheet shall comply with the requirements of ASTM A366M, unexposed class. Horizontal steel sheet waterstops in vertical joints shall be installed with sufficient slope to avoid air trapping with the formwork.
- k) Steel sheet waterstops at horizontal construction joints shall be gas shiled welded to lateral steel flanges of connecting elastomeric waterstops. Alternatively, steel sheet waterstops may be bolted to the lateral steel flanges of connecting elastomeric waterstops with a 3 mm raw rubber sealing strip in between. Details proposed by the Contractor shall be subject to approval by the Employer.

5.11.1.2 Cold Joint

- 1) A cold joint is an unplanned joint which is the result of hardening of the concrete surface before the next batch is placed against it. Cold joints are undesirable and should be avoided.
- 2) In the event of equipment breakdown, or other unforeseen prolonged interruption the continuation of placing may be not allowed. When such an event occurs, and the unconsolidated concrete may harden to the extent that later vibration would not fully consolidate it, the Contractor shall immediately consolidate such concrete to a stable and uniform slope.
- 3) If delay in placement is short and it is still feasible to penetrate the underlying concrete, placement shall resume with care to thoroughly penetrate and re-vibrate the concrete surface placed before the delay.
- 4) If the concrete cannot be penetrated with the vibrator, the cold joint shall be treated as a construction joint, if the design requirements tolerate such joint. If such joint would impair the structural integrity of the structure, as determined by the Employer, the concrete, or a part of it, shall be repaired or removed as directed by the Employer.

5.11.1.3 Construction Joints for Stage Concreting

- 1) Construction joints for stage concreting are joints, or joint systems where infill concrete or bays shall not be placed before one or several months after placing of the first stage concrete.
- 2) Such joints are provided for installation of major and minor equipment pieces in the floor and walls in certain structures and may be shown on the Tender Drawings.
- 3) Waterstops shall be provided in construction joints for stage concreting, where shown in the construction drawings or otherwise directed by the Employer.
- 4) When shown on the construction drawings or when necessary, as determined by the Employer, surfaces of construction joints for stage concreting shall be cleaned and roughen by bush-hammering after removal of the forms and prior to

placement of the second stage concrete. These surfaces may be penetrated by a number of reinforcement bars.

5.11.2 Expansion Joints

5.11.2.1 General

- 1) Expansion joints in the concrete structures shall be constructed at such locations and to such dimensions as shown on the Construction Drawings . The Contractor shall supply and install the various joint components as specified herein, as shown on the Construction Drawings and in accordance with the manufacturers recommendations.
- 2) No fixed metal embedded in the concrete shall be continuous through an expansion joint except where expressly shown on the Construction Drawing.
- 3) Expansion joints are joints provided in concrete structures to prevent transfer of forces from structure to structure or to accommodate volumetric changes due to temperature rise. Expansion joints may be provided with the following elements as shown on the Construction Drawings:
 - Elastomeric waterstop
 - Steel dowels
 - Concrete shear keys
 - Preformed expansion joint filler panels
 - Bond breaker bituminous coating
 - Joint sealer
 - Elastomeric strips (see Section 6.5.2)

5.11.2.2 Materials

- 1) Elastomeric waterstops shall comply with the requirements of DIN 7865 and shall be, as shown on the Drawings, 2235 RMD and 2345 RMD with lateral steel flanges, as supplied by Gumba of Germany, or approved equivalent. Elastomeric waterstops and strips shall have the following properties:
 - a) Tensile strength $> 10 \text{ N/mm}^2$
 - b) Elongation at break $> 380\%$
 - c) Tear propagation strength $> 8 \text{ N/mm}$
- 2) Steel dowels shall be about 40 cm long plain steel bars conforming to ASTM A615M, Grade 400, diameter approximately 25 mm. Prior to placing the subsequent pour, each bar shall be wrapped or coated to half the length with

bituminous materials acceptable to the Employer. As an alternative to such coating a galvanised mild steel or PVC cap may be used.

- 3) Preformed expansion joint filler panels shall consist of expanded polystyrene, 30 mm thick, with a specific weight of approximately 20 kg/m³. They shall be waterproof and shall not absorb water. Alternative materials complying with the requirements of ACI 504R may be proposed by the Contractor for the Employer's approval.
- 4) Bond breaker bituminous coating shall be used to facilitate independent movement between two units that would otherwise behave monolithically and shall consist of 2 layers of a product similar to IGOL-T as supplied by Sika Switzerland, or equivalent.
- 5) Joint sealer shall be a sealing cord based on closed-cell elastomers with a smooth outer skin and a circular cross-section as supplied by Fermadur of Germany, or approved equivalent, and shall have the following properties:
 - a) - Tensile strength > 2 N/mm² DIN 4060
 - b) - Breaking strain > 350% DIN 4060

5.11.2.3 Construction

- 1) Expansion joints shall be formed with F2 finish.
- 2) Waterstops shall be joined and fixed in place in accordance with manufacturer's recommendations to form a continuous watertight barrier. All cross-pieces, T-pieces and corner-pieces shall be factory produced. All remaining linear joints shall be hot vulcanised on site in accordance with the manufacturer's recommendations. All splices shall be neat with the ends of the joined waterstops in true alignment. A manufacturer's own specialist shall be appointed for on-site training of the Contractor's labour until such labour becomes **skilled** to the satisfaction of the manufacturer and the Employer. A mitre-box guide and portable knife shall be provided for cutting the ends to be joined to insure good contact between joined surfaces. The Contractor shall supply all necessary supports and ties required for placing the waterstop and shall position it so that its central axis coincides with the joint centre. Care **shall** be taken that waterstop does not bend or deflect during concreting. Concrete adjacent to the waterstop shall be thoroughly worked to ensure full contact with the waterstop but without damaging it. Prior to commencement of concrete placing, the waterstops placed shall be inspected by the Employer.
- 3) Before casting the second part of an expansion joint, the whole surface will be covered with preformed expansion joint filler panels as shown on the Construction Drawings. The panels shall be cut to the size and shape of the joint and shall be glued (or clamped by methods to be approved by the Employer) onto the joint face and tightly joined. Holes and joints in the filler panels shall be filled with mastic to prevent passage of mortar or concrete from one side to the other. Particular care shall be taken to ensure that all surfaces of the shear keys are covered.
- 4) Before applying the joint sealer, the joint shall be raked out to a depth as specified. All laitance, dirt, oil and foreign matter shall be removed from the joint by sandblasting, compressed air, grinding discs, or other effective means, and

the concrete surfaces coated with an approved suitable primer as recommended by the sealer manufacturer. Joint sealer shall be placed after the concrete curing period in accordance with manufacturer's instructions. The concrete surface temperature shall not be higher than 30°C at the time of placing unless otherwise approved, and the concrete shall be surface dry. After placing, the sealer shall be protected from the effects of water for a period of at least 10 hours.

- 5) Joint sealer that becomes unbonded from the concrete, or cracks, or shows any other defects before final acceptance of the work, shall be replaced by the Contractor.
- 6) Bituminous coating or elastomeric strips of adequate thickness shall be used as bond breaker on the inclined surfaces of the shear keys where expansion joint filler is not used. Details shall be shown on Construction Drawings.

5.12 Preparation for Concrete Placing

5.12.1 General

- 1) All surfaces of forms and embedded items that have become encrusted with dried material from concrete previously placed shall be cleaned of all such material before the surrounding or adjacent concrete is placed.
- 2) Concrete shall not be placed in any structure until any water in or flowing into the space to be filled with concrete has been properly removed or diverted by pipes, or by other means. Water shall not be allowed to stand on any concrete surface until it has attained its initial set. Water flow over the concrete, which may injure the surface finish will not be allowed.
- 3) Pipes, conduits, dowels and other items to be embedded in concrete shall be so positioned and supported prior to placement of concrete to be stable and provide sufficient clearance (50 mm minimum) between said items and steel reinforcement to allow proper concreting. Securing such items in position by wiring or welding to reinforcement will not be permitted.
- 4) Where excavated surfaces which are to form the foundations for structural concrete are absorptive or likely to become otherwise unsuitable, or where shown on the Construction Drawings, the Contractor shall place a "blinding course" consisting of a layer of Class 15/25 concrete 10 cm thick, as directed by the Employer, uniformly over the foundation such that the upper surface is at grade elevation. This lean concrete shall be placed before installing reinforcement or formwork.
- 5) Immediately before concreting, the forms and all other surfaces which will be in contact with the fresh concrete shall be cleaned of all loose material and debris including shavings, wood chips, sawdust, pieces of wire, nails, fragments of hardened concrete and mortar. Clean out holes which may be needed for this purpose shall subsequently be securely closed in order to obtain the required surface finish.

- 6) The use of compressed air for cleaning will be allowed only if adequate precautions are taken to avoid the deposition of suspended oil on construction joint surfaces, reinforcement or other items which are to be bonded to concrete.
- 7) The Contractor shall provide such personnel and equipment to ensure proper performance of concrete work. The transporting and placing equipment shall be clean and in good condition, adequate, and properly arranged to proceed with the placing without delays. A sufficient number vibrators including standby units shall be available in good working condition at any time during placement. The lighting system shall be sufficient to illuminate the inside of the forms when concrete is placed at night.
- 8) The Contractor shall have protective coverings available for fresh concrete surfaces if there is a possibility of rain.

5.12.2 Concrete Cast against or upon Previously Placed Concrete

Before any concrete is cast against previously placed concrete, the surface of the old concrete shall be prepared as described in Section 5.11.1, Construction Joints.

5.13 Production of Concrete

5.13.1 Concrete Mixes

- 1) During the progress of the work, the proportions of material entering into the concrete mixes may be changed in accordance with ACI 301 Section 3.11. or whenever, in the opinion of the Employer, such change is necessary or desirable to secure the required strength, workability, watertightness, density, economy, or to limit the heat of hydration and shrinkage.

In view of the large dimensions of pours, and the need for limiting the work of compaction, most of the concrete will be pumped. This requires pumpable consistency of the concrete with a slump at placement between 15 and 20 cm.

- 2) To maintain the proper consistency, the amount of water and sand batched for concrete shall be adjusted to compensate for variations in the moisture content or the gradation of aggregates as they enter the mixer.

5.13.2 Batching

- 1) The Contractor shall provide, operate, and maintain at the site a modern and dependable batching type mixing plant of a capacity sufficient to meet the construction schedule and conforming to the related requirements of ASTM C94.
- 2) All equipment for batching material and mixing concrete shall conform to the following standards of the Concrete Plant Manufacturers Bureau, affiliated with the US National Ready-Mixed Concrete Association:
 - Concrete Plant Standards,
 - Concrete Plant Mixer Standards.

An Individual Cumulative Automatic Weigh Batching Plant, as defined per ACI 304 is required. All material entering the concrete mix shall be mechanically batched and measured by weight, except for water and admixtures, which may be measured by volume. Weighing tolerances shall comply with ACI 304. The batching plant shall have the facilities to separately weigh the different types of cementitious materials used for preparation of the concrete.

- 3) The scales shall be interlocked so that a new batch cannot be started until the weighing hoppers have been completely emptied of the last batch and the scales are in balance. Provisions for easy removal of excess materials, shall be incorporated in the equipment. Dials shall be in full view of the operator and the weighing equipment shall be arranged so that the operator may conveniently observe the operations of the batcher gates and the discharge of the materials.
- 4) The batching plant shall be equipped with a wattmeter, a slumpmeter or any other approved concrete workability meter to assess the consistency of the batch in the mixer, and the equipment shall be capable of adjustment to compensate for the varying moisture content of the sand and coarse aggregates and to adjust the mix proportions as needed. The moisture content of the fine and coarse aggregates shall be determined regularly. Electric resistances shall be provided in the sand bins, correlated to dials on the batching console. The electrodes shall enter to within 30 cm of the batcher discharge gate. The batching console shall allow for ready water adjustment.
- 5) The plant shall include a device suitable for proportioning admixture. The discharge mechanism of the device shall be interlocked with the discharging operation of the water, so that the batching of admixture will be automatic. The device shall be capable of ready adjustment to allow for varying the quantity of admixture to be batched.
- 6) Aggregate batch bins shall be self-cleaning during drawdown. Suitable facilities shall be provided for readily obtaining representative samples of aggregates from each of the batcher for test purposes and from the mixer. Finish-screening of coarse aggregate will not be required provided that the aggregate meets the gradation requirements stipulated in this Section. Coarse aggregate not meeting the gradation requirements, shall be finish-screened over vibration screen connected to the batching plant or on the ground adjacent to the batching plant. The finish screens, if installed on the batching plant, shall be so mounted that the vibrations of the screens will not affect the accuracy of the batching scales. The finished products shall pass directly to the batching plant bins.
- 7) Each weighing unit shall be springless and will register the scale load at any stage of the weighing operation from zero to full capacity. For water measuring, two water meters shall be installed in parallel so that no delay due to faulty operation shall occur. No leakage may occur when the valves are closed. Liquid admixtures dispenser shall be of the visual type and shall be interlocked with the batching plant to prevent overdosing.
- 8) A digital Concrete Certification Recorder shall document, in accordance with the Concrete Plant Standards, information on each material used in the mixture along with the concrete mixture identification for each load. In addition, records shall be kept of:
 - sand(s) moisture contents,

- date and time of the day,
- truck number, if concrete is truck-transported and location of placement.

The report shall indicate type and source of cement and pozzolan used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic meter, amount of water as free moisture in each size of aggregate and the batched aggregate and water weights per cubic meter for each class of concrete batched during plant operation.

The quantities recorder shall be located in an enclosed room adjacent to the batching and mixing plant where it can be viewed without interfering with batching operation and where it is isolated from vibration and dust.

9) Admissible errors in batching shall be as follows:

Material	Cement and Flyash	Water and Ice	Admixtures	Aggregate
Error in percent	1%	1%	3%	2%
Measured by:	Weight or Volume	Weight or Volume	Weight	Weight

- 10) Conveying batched materials from weighing hoppers into the mixer shall be so constructed and operated that spillage of the batched materials and overlap of batches is prevented.
- 11) Construction and operation of the cement and pozzolan handling equipment shall be such that no noticeable dust will be raised during measuring and discharging of each batch of material.
- 12) The Contractor shall provide standard test weights and any other equipment required for checking the operating performance of each scale or other measuring device. Periodic tests according to the manufacturer's instructions shall be made in the presence of the Employer. Facilities for obtaining representative samples of concrete materials, between batch bins and the weighing hoppers or between the batch hopper and the mixer, shall be provided with the batching equipment. The Contractor shall make such adjustments, repairs, or replacements as may be necessary to meet the specified requirements for accuracy of measurement.

5.13.3 Mixing

5.13.3.1 General

- 1) Concrete shall be mixed in power-driven stationary batch mixers as specified in Section 5.13.2 above. They shall be kept clean and in proper working order. The mixing blades in the drum shall be replaced when worn by 10% of their design dimensions.
- 2) Movable truck mixers shall not be permitted for mixing concrete.

- 3) Concrete mixing equipment shall be capable of combining all ingredients into a uniform mixture within the time limit specified hereafter and of discharging this mixture without segregation. If more than one liquid admixture is used, these shall be discharged separately into the batch. The plant assembly shall be such as to facilitate the inspection of all operations at all times.
- 4) Batching and mixing of concrete shall not commence unless due notice, at least 24 hours in advance, has been given to the Employer, and his Concrete Permit has been obtained prior to start of the pour.
- 5) The quantity of material in each batch shall not exceed the normal continuous rated capacity of the mixer and the speed of rotation shall be within 1 rpm of the manufacturer's recommended speed.
- 6) Components shall be fed into the mixing drum so as to ensure the most efficient use of the mixing period and to avoid any loss of material. In no case shall the mixers be overloaded above their rated capacity recommended by the manufacturer. Uniformity in concrete consistency from batch to batch will be required.
- 7) Mixing is considered to have started when all solid materials are in the mixer drum, provided that all the mixing water is introduced within one fourth of the mixing time. The further addition of water shortly before completion of mixing and excessive over-mixing requiring addition of water to preserve the required concrete consistency will not be permitted.
- 8) The first batch of concrete in the mixer shall contain sufficient excess cement, sand and water to coat the inside of the drum without reducing the required mortar content of the mix. The entire content of the mixer shall be removed from the drum before materials for a succeeding batch are placed therein.
- 9) Mixing of concrete shall not commence without ensuring that the stocks of materials are adequate, with a reasonable safety margin, for the completion of the particular pour of concrete.
- 10) The mixing time of each batch shall be determined by the batching and mixing tests based on manufacturer's recommendations. Mixing time shall be adjusted according to mix compositions and the mixers used and shall be at least 45 s after all components have been added. In the case of concrete containing admixtures, a minimum mixing time of 60 s shall be observed [see also Section 5.14.2, 4)]. The Employer may direct that the mixing time be varied whenever the charging and mixing operations fail to produce a concrete batch having the ingredients uniformly distributed and constant consistency.
- 11) Each mixer shall be equipped with a mechanically operated timing and signalling device which will indicate and ensure the completion of the required mixing period and will count the batches.
- 12) The Employer reserves the right to vary the mixing time or to limit the batch size when the batching and mixing operations fail to produce a concrete conforming to the requirements set out during the trial mix stage.
- 13) Retempering of concrete or mortar is not permitted.

5.13.3.2 Trial Run and Performance Control

- 1) At least 21 days prior to starting any Permanent Works concreting, the Contractor shall carry out a trial concrete production run.
- 2) All plant and materials used shall be those to be used for the actual production of concrete in the Permanent Works.
- 3) The Contractor shall make all adjustments necessary to produce concrete of the quality of the agreed trial mixes of each class. Only when this has been achieved will the Employer give consent to proceed with Permanent Works concreting.
- 4) The performance of the mixers shall be controlled in accordance with the provisions of ASTM C94 and Designation 26 of USBR "Concrete Manual".

5.13.4 Transporting

- 1) The method and facilities for concrete transport shall be selected by the Contractor within the limitations of these Specifications, and he shall be responsible for the adequacy and suitability of the transporting system. The time elapsing between mixing and the initial set of the concrete shall be taken into consideration.
- 2) The concrete transporting methods and facilities shall be such that they will prevent segregation of coarse aggregate, excessive loss of slump, and loss of ingredients. All equipment shall be kept clean and in good working condition.
- 3) Truck mixers and agitators shall conform to the Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers Bureau.
- 4) Concrete mixed in central stationary mixers shall be delivered to the placement location and discharge shall be completed within 30 min after introduction of the cement at the batching plant.
- 5) The capacity of bucket haulers shall be the same as that of the concrete batch size or a multiple thereof in order to prevent the splitting of batches. The dumping mechanism shall permit discharge of small portion of concrete in one place. Buckets shall be capable of prompt discharge of low-slump, lean-mix concrete with maximum aggregate size to be used.
- 6) Transportation of concrete by non-agitating cars or trucks shall be limited to mixes with a slump not more than 1 cm. Free water shall not stand on the surface of concrete when delivered in cars or trucks.
- 7) If concrete is to be placed by tipping, chutes shall be used to prevent segregation, their ends being placed just above the placing point. The slopes of chutes for conveying fresh concrete shall be chosen so that the concrete with minimum water content flows in a steady stream without segregating. Effective end control that will produce a vertical drop and prevent segregation of ingredients shall be provided. The chutes and belt conveyors shall be protected from wind and sun.

- 8) When more than one mix is used at any given time, trucks shall carry an identification flag or mark, identifying the mix transported.
- 9) All trucks, drums, pipelines and other transporting devices shall be washed only in approved locations. Truck mixers and agitators shall be washed at frequent intervals so as to prevent mortar build up within the equipment. All wash water shall be wasted prior to taking on another load.

5.13.5 Communications

- 1) The Contractor shall furnish, install, maintain and operate a telephone system or radio, linking the points of placing concrete with the concrete batching and mixing plant. These facilities shall also be available to the Employer at all times.
- 2) When placing the concrete by pumping, direct communication shall be maintained between the concrete placing crew and the pump operators.

5.14 Temperature of Concrete

5.14.1 Maximum Placing Temperatures and Temperature Control for Massive Structures

- 1) The maximum permitted temperature rise in concrete and temperature distribution after placement will be determined by the Employer based on the laboratory test performed prior to the start of concrete work using the actual cement, concrete mix proportions, and diffusivity for the concrete under consideration, or by actual field monitoring.
- 2) The temperature of concrete when being placed shall be determined at the Proportioning and Trial Mixes stage and in accordance with ACI 223, Standard Practice for the use of Shrinkage-Compensating Concrete. Unless otherwise approved by the Employer it shall not exceed the following values:
 - mass concrete, not more than 25°C,
 - structural concrete, not more than 30°C.
- 3) Concrete pour sizes, lift thicknesses, curing methods and the time lapse between pours shall be such as to limit peak temperature due to heat of hydration to 53°C within the interior "core" of a pour and the temperature difference (i.e. the gradient) developed between the surface concrete and the interior concrete at any section to 20°C at any time in order to limit the risk of thermal cracking, and to limit the shrinkage stresses. Interior and exterior temperatures shall be monitored unless otherwise directed by the Employer. The Contractor shall provide his proposed monitoring plan for the Employer's approval.

5.14.2 Hot Weather Concreting

- 1) The Contractor's concreting operations shall be in accordance with the recommendations of ACI 207.1R, Mass Concrete for Dams and Other Massive Structures, ACI 224R, Control of Cracking in Concrete Structures, ACI 305R, Hot Weather Concreting as well as ACI 301, Specifications for Structural Concrete for Buildings.
- 2) The Contractor shall furnish, install, operate, and maintain equipment and make the necessary provisions in order to maintain the temperature of concrete, when being placed, below the maximum temperatures specified herein.
- 3) The Contractor shall employ the following means to keep the specified concrete temperatures:
 - a) Pre-cooling of coarse aggregate by sprinkling, immersion in cold water or with cold air blast.
 - b) Refrigerating the mixing water or adding chip or flake ice as a portion of the mixing water.
 - c) Liquid nitrogen injection in the mixer may be permitted by the Employer after review of proposed details.
 - d) Insulating the water tanks and water supply lines, cement silos, mix drums, exposed pipelines for pumped concrete and sheltering the aggregates.
 - e) Mixing and placing the concrete at night.
- 4) Ice, when used for mixing with water, shall be completely melted before concrete mixing is completed.
- 5) The temperature of concrete at the mixing plant shall be at least 2°C lower than that specified for placing temperature.

5.15 Concrete Placing

5.15.1 General

- 1) Concrete shall not be placed until all formwork, installation of embedded parts, reinforcing steel, and surfaces against which concrete is to be cast have been inspected and approved in writing by the Employer in the form of a concrete permit issued to the Contractor for each single pour. Concrete placed in violation of this provision may be rejected and removal required.
- 2) The Concrete Permit form shall be prepared and filled by the Contractor's superintendent in charge of the related pour. It will record at least the following:
 - a) Proposed date and times of commencing and finish of placing
 - b) Location
 - c) Reference drawings

- d) Climatic conditions
 - e) Composition of the mix
 - f) Volume to be placed
 - g) Foreman in charge
 - h) Equipment used, including vibrators for consolidation
 - i) Availability of protection and curing equipment
 - j) Cleaning and preparation performed
 - k) Reinforcement placed
 - l) Formwork used
- 3) Concrete shall be placed before initial set as per ASTM C403 has occurred and in any case within 30 minutes of being discharged from the central mixer when no retarder admixture is used.
- 4) No concrete shall be placed when the atmospheric conditions are, in the opinion of the Employer, such that proper placing and hardening of the concrete are not guaranteed. Specifically, the Contractor shall have the responsibility for meeting the hot weather concreting requirements and for postponing concreting whenever such requirements cannot be met or, based on weather forecast, probably cannot be met.
- Compliance with the hot weather requirements does not relieve the Contractor from his responsibility to produce concrete that meets the Specifications.
- 5) Concrete, which is found not to be in conformity with the requirements specified herein or has been placed without the knowledge and authorisation of the Employer, shall be rejected and removed from the Works and replaced by the Contractor.

5.15.2 Casting Sequences

- 1) The time between successive lifts and maximum permissible depth of concrete placed in one lift, unless otherwise directed or shown on the Construction Drawings, shall be as follows:

Location	Maximum Permissible Depth of One Lift	Minimum Time between Successive Lifts
Mass concrete in massive structures	250 cm	72 h
Powerhouse substructure	150 cm	24 h
2 nd stage concrete around stay ring and draft tube	depending upon manufacturer specification	72 h
Walls and piers less than 4 m thick	250 cm	48 h

- 2) Concrete for beams, slabs and similar members shall be placed to the full depth in a single operation.
- 3) Outdoor concreting shall not be started during rain. If concreting is already in progress during the rain, it shall be suspended if the rain adversely affects the quality of the placed concrete.
- 4) Concrete that has been allowed to harden to the extent that additional concrete placed on it will not satisfactorily bond shall be treated as a construction joint. When stoppage of concreting operations occurs for any reason, construction joints shall be placed either horizontally or vertically as needed.

5.15.3 Placing and Consolidation

- 1) Concrete shall be placed in accordance with requirements of ACI 301, Specifications for Structural Concrete for Buildings, and ACI 304R, except as modified by the supplemental requirements below. Where dense reinforcement or deep forms may cause segregation of concrete while placing, chutes shall be used to prevent segregation. The free fall of concrete shall not exceed 1.5 m.
- 2) Concrete shall be placed directly in its permanent position and shall not be worked along the forms to that position. Vibrators shall not be used to move concrete laterally. When concrete is placed with buckets, not more than 2 m³ may be deposited in one operation for consolidation.
- 3) The addition of water into concrete after batching to compensate for stiffening of the concrete before placing shall not be permitted.
- 4) All concrete shall be placed in continuous approximately horizontal layers. The thickness of the layers shall not exceed 50 cm. Each layer shall be soft when a new layer is placed upon it so that no seams or planes of weakness within the section can form, and the two layers shall be made monolithic by penetration of vibrators.
- 5) The Employer reserves the right to order a reduced thickness of layers where the layers as stated above cannot be placed in accordance with the requirements of these Specifications.
- 6) Each layer of concrete while being placed shall be consolidated by mechanical vibration to form a dense, homogeneous material free from voids. The concrete shall be worked up hard against adjoining surfaces. Each concrete layer shall be consolidated completely before another layer of concrete is placed upon it.
- 7) Consolidation of concrete shall be carried out in accordance with ACI 309. Mechanical internal vibration equipment, supplemented by hand spading, rodding or tamping shall be used. In no case shall vibrators be used to transport concrete inside the forms. Vibrating equipment shall be of the internal type and shall at all times be adequate in number of units and power of each unit to consolidate all concrete properly. Form or surface vibrators shall not be used.

Internal vibrator characteristics shall comply with ACI 309 Table 5.1.5 with regard to the mix consistency. The duration of vibration shall be limited to that necessary to produce satisfactory consolidation without causing objectionable segregation. Vibrators shall be inserted in the deposited layer so that

homogeneity of consistency is achieved with the precedent layer, then withdrawn slowly, at a grid spacing of approximately 40 to 65 cm. apart. One insertion shall extend from 5 to 15 seconds or until rising air bubbles are nearly eliminated. Vibrated areas of influence shall overlap.

Insertion of the vibrator into a lower layer that has commenced initial set, or the disturbance of reinforcement embedded in concrete beginning to, or already set shall be avoided. Care shall be taken to avoid contact with reinforcing bars or embedded items.

For thin walls or inaccessible portions of the forms, where rodding or vibrating internally is impracticable as determined by the Employer, the concrete shall be assisted into place by tapping or hammering the forms opposite the freshly deposited concrete. Vibrators or pneumatic hammers shall never be applied to the exterior face of forms.

- 8) Vibrators shall be operated by experienced workers only.
- 9) The total consolidating capacity, in cubic meter of concrete per hour, of all vibrators in effective operating condition, and employed on concrete consolidation in the Works, shall be based on a rated capacity of 80% of the manufacturer's recommendations for each type of vibrator. The total consolidating capacity so computed shall not be less than the maximum rate at which concrete is placed in the Works. For every four vibrator in use on the Works, an additional standby vibrator of similar consolidating capacity and in good working order, shall be available for use no more than 15 min from the location of the consolidation.
- 10) The Contractor shall modify his vibrating equipment if it does not perform satisfactorily under operating conditions.
- 11) Internal struts, stays and braces, serving temporarily to hold the forms in correct shape and alignment impeding the placing of concrete shall be removed when the concrete placing has reached an elevation rendering their service unnecessary.
- 12) For concrete placed in monolithic columns and floors or beams or joists and floors or in walls having openings for doors or windows or other purposes, concrete placing at the top of joists or beams or columns and in walls at the level of the top of the opening shall be suspended for a period of time to allow concrete placed to settle. After settlement and bleeding has ceased, placing concrete shall resume.
- 13) The Contractor shall take care to prevent formation of cold joints during placing concrete in any part of the Works. His concrete-placing rate shall be such that the concrete is placed while the previously placed adjacent concrete is still plastic and the concrete can be made monolithic by normal use of vibrators.

5.15.4 Pumping Concrete

- 1) Placing concrete by pumping methods shall be carried out in accordance with all requirements of ACI 304.2R, except as modified by the supplemental requirements below.

- 2) Positive displacement pumping or other approved methods may be used to place concrete in locations approved by the Employer. The type and arrangement of equipment shall be subject to approval by the Employer, and the equipment shall be operated only by experienced persons. Pneumatic placing will not be allowed.
- 3) The equipment and its method of operation shall allow the concrete to enter the forms at a low velocity.
- 4) Concrete pumps and auxiliary equipment shall be in good condition and shall be maintained as such throughout the duration of the work. Thorough washing down of all parts that come in contact with concrete shall be performed after each concreting operation.
- 5) Pump-lines shall consist of rigid steel pipe or flexible pipe made of rubber, spiral-wound flexible metal or plastic, or combination of both. Use of aluminium pipe for pump-lines shall not be permitted. Couplings shall be leak proof and strong enough to withstand handling during erection. They shall provide a full internal cross section with no constrictions of the smooth flow of concrete.
- 6) Immediately prior to the start of all concrete pumping, the pump and pump-lines shall be primed by pumping an approved grout mixture through the equipment.
- 7) Concrete pumping operations shall be planned in such a way that concrete does not set before the succeeding layer is placed thereon. An adequate supply of fresh concrete shall be provided at all times.

5.15.5 Placing Concrete under Water (Tremie Concrete)

- 1) Concrete will be placed underwater only when and where approved by the Employer. Placement shall be carried out by tremie method in accordance with the requirements of ACI 304R.
- 2) The tremie pipe shall have a diameter between 200 and 300 mm. The pipe shall have a funnel-shaped upper end for feeding with concrete. The pipe shall be plugged by approved seal to prevent ingress of water at the start of concreting. The pipe shall be composed of sections of suitable length with quick release watertight joints.
- 3) Hoisting equipment for raising and lowering the pipe and tools for bolting and unbolting pipe sections shall be continuously available during concreting.
- 4) Placement by tremie shall start slowly to minimise scouring of the bottom or washing of previously placed concrete. The bottom of the tremie pipe shall remain in fresh concrete at all times after placement has started. The pipe shall be lifted slowly maintaining the bottom of the pipe embedment to a level to assure the desired rate of flow.
- 5) Should the bottom of the pipe be lifted out of the fresh concrete, the pipe shall be removed and new seals established and concreting started over again.
- 6) Batches of concrete shall be supplied to the tremie pipe at a uniform rate for a continuous flow. The Contractor shall assure that there will be no longer delays than 5 minutes between the batches.

- 7) The concrete mix proportions shall differ from ordinary structural mixes and shall be established by trials in order to obtain the mix which flows into place by gravity without vibration or mechanical help.
- 8) The maximum aggregate size shall be 38 mm and fine aggregate shall be in the range of 40 to 50% of the total weight of aggregates. At least 50 kg of extra cement per cubic meter shall be added to the required concrete class.

5.16 Protection and Curing

5.16.1 Protection

- 1) The Contractor shall protect all concrete against injury or damage from excessive heat, or frost, lack of moisture, overstress, or any other cause until taking over by the Employer.
- 2) Fresh concrete shall be protected from damage such as due to drying, sunshine, rain, and traffic. The Contractor shall provide such protection while the concrete is still plastic and whenever such precipitation, either periodic or sustaining, is imminent or occurring.
- 3) Care shall be taken not to disturb the concrete by direct or indirectly loading, striking of forms or otherwise, until it has hardened sufficiently.
- 4) Construction loads shall not be allowed on beams, decks or slabs until the concrete has attained its design strength, nor shall the Contractor impose loads exceeding the design loading.
- 5) All fresh concrete surfaces shall be protected from contamination and from foot traffic until the concrete has hardened. Surfaces which have received the U2 or U3 finishes shall be protected by covering with protective mats, plywood, or other effective means approved by the Employer.

5.16.2 Curing

5.16.2.1 General

- 1) All concrete shall be moist cured in accordance with all requirements of ACI 308 Chapter 3, Section 3.3, Mass Concrete, for a period of not less than 14 consecutive days from November to April inclusive and 21 days from May to October inclusive. Curing shall be carried out by an approved method or combination of methods applicable to local conditions. The Contractor shall have on hand, and ready to install, all equipment and materials needed for adequate curing of concrete before actual concrete placement of each pour begins. The curing medium and method, or the combination of mediums and methods, will be subject to approval of the Employer.
- 2) During the months from May to October, formwork shall be sprayed with water at frequent intervals from the time the concrete is placed until the formwork is removed. If formwork is left in place after the times set in Section 5.10.6, Removal of Formwork, the forms shall be loosened and the space between the forms and the concrete wetted thoroughly at frequent intervals.

- 3) Lean concrete shall be cured as shall any other class of concrete. Furthermore it shall remain protected up until the time the structural concrete is placed above.

5.16.2.2 Water Curing

- 1) Water curing shall conform to all requirements of ACI 308, 2.2. Water used for curing shall meet the requirements of mixing water, free of deleterious materials and substances that will stain or discolour the concrete.
- 2) Water curing shall start as soon as the concrete has hardened sufficiently to prevent damage by erosion and shall continue for the duration of the entire curing period or until covered with fresh concrete. All surfaces shall be kept continuously wet during curing. Wetting the surfaces only periodically will not be permitted.
- 3) Water curing shall be carried out by following methods:
 - a) Spraying or sprinkling by a system of perforated pipes, lawn sprinklers, soaking hoses or by other approved methods; intermittent sprinkling will not be acceptable
 - b) Covering the concrete surfaces with burlap, cotton mats, or rugs which will hold water on the surface either horizontal or vertical; the covering materials shall be kept continuously water-saturated during the curing period
 - c) Covering the horizontal construction joints and finished surfaces with a minimum thickness of 50 mm of sand which shall be kept uniformly distributed and continuously saturated during the curing period
 - d) Water curing of construction joints may be terminated six hours immediately prior to placing of the following lift, provided that the required wetting period has been met.

5.16.2.3 Membrane Curing by Sealing Compound

- 1) Sealing compounds shall be used for concrete curing only if approved by the Employer. Sealing compounds will generally be accepted on manufacturer's certification of compliance with specifications, but such acceptance shall in no way relieve the Contractor of the responsibility for furnishing a compound which meets the requirements of this Specification. Sealing compounds will be subject to sampling and testing.
- 2) The liquid membrane-forming compounds for curing concrete shall conform to the requirements of ASTM C309. The compounds shall be of uniform consistency and quality within each container and from shipment to shipment. When approved, the membrane curing shall be performed by application of the sealing compound which forms a water-retaining membrane on the surfaces of the concrete. The sealing compound shall be white-pigmented Type 2, except that compound used on surfaces that will be exposed permanently to view shall be Type 1 or 1-D.

- 3) Sealing compound shall not be used on concrete surfaces to which additional concrete, paint or tile is to be bonded, unless the Contractor has demonstrated that the membrane can be satisfactorily removed before subsequent application or can serve satisfactorily as a base for the application.
- 4) When sealing compounds are used on unformed concrete surfaces, application of the compounds shall commence immediately after finishing operations are completed. When sealing compounds are to be used on formed concrete surfaces, the surfaces shall be moistened with a light spray of water immediately after the forms are removed and shall be kept wet until the surfaces will not absorb more moisture. As soon as the surface film of moisture disappears but while the surface still has a damp appearance, the sealing compound shall be applied.
- 5) Special care shall be taken to ensure ample coverage with the compound at edges, corners, and rough spots of formed surfaces. After application of the sealing compound has been completed and the coating is dry to touch, any required repair of concrete surfaces shall be performed. Each repair, after being finished, shall be moistened and coated with sealing compound in accordance with the foregoing requirements.
- 6) Equipment for applying sealing compounds and the method of application shall meet with the approval of the Employer. Traffic and other operations by the Contractor shall be such as to avoid damage to coatings of sealing compounds for a period of not less than 21 days. Any sealing membrane that is damaged or that peels from concrete surfaces, within 28 days after application, shall be repaired without delay.
- 7) Sealing compounds used for surfaces exposed to view shall degrade completely when exposed to air for more than 3 months. They are to remain at least 80% impermeable for one month after application.

5.17 Repair of Defective Concrete

5.17.1 General

- 1) Concrete which is damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established position, line or grade, or which, for any other reason, does not conform to these Specifications, shall be satisfactorily repaired, or removed and replaced with acceptable concrete by the Contractor.
- 2) The Contractor shall correct all imperfections on the concrete surface as necessary to produce the specified finish within the time as specified below:
 - Minor formed surface repairs, such as surface grinding, shall be completed within 24 hours after form removal.
 - Concrete replacement less than 25 cm thick, mortar and dry-pack repairs shall be completed within 7 days after the original concrete placement.

- Concrete replacement more than 25 cm thick, epoxy-resin bonding repairs, and all other repairs shall be completed after 7 days, but before 56 days after the original placement.
- 3) All repair work shall be finished to the same standard as the surrounding concrete, and shall be adequately cured. Plastering or rendering of surfaces to produce a smooth surface finish shall not be permitted.
 - 4) No repair work shall be carried out before the Employer has inspected the defective area and given consent in writing for remedial work to begin.
 - 5) Concrete requiring F1, F1C, U1, F2, F2C or U2 finish that is honeycombed, fractured, that contains surface depressions which exceed the allowable tolerance specified in this Section or that is otherwise defective shall be cut back to a minimum depth of 40 mm into sound concrete in all directions, and the edges undercut. The area to be removed shall be outlined to a depth of 15 mm with a diamond or carborundum saw prior to removing the defective concrete. The fresh concrete surface shall then be cleaned, washed down and thoroughly soaked with water until the concrete becomes saturated. The concrete surface should be damp. Repairs to the surface shall then be carried out using the materials and methods described hereafter.
 - 6) For bonding new concrete to older one, a bonding medium of epoxy, formulated for this purpose, shall be used in accordance with manufacturer's instructions. Alternatively, a neat cement paste may be used. A paste of cement and water mixed to a thick cream consistency shall be applied to damp, clean concrete. The concrete shall have no free water on the surface.
 - 7) Concrete requiring F3, U3 or U3C finish that is honeycombed, fractured, that contains surface depressions which exceed the allowable tolerances specified in this Section or that is otherwise defective shall be repaired as follows:
 - *Minor areas of defective concrete:* The Contractor shall drill a hole of such diameter in the defective area into sound concrete, that the defective concrete is completely removed. The minimum diameter of such hole shall be 50 mm, the minimum depth shall be equal to the diameter of the hole drilled and the maximum depth shall be 70 mm. The hole shall then be reamed out such that the diameter at the bottom of the hole is at least 20 mm larger than the hole at the surface. Finally, the hole shall be cleaned and washed out, the surplus water removed, and then filled with concrete incorporating a non-shrink agent approved by the Employer.
 - *Large areas of defective concrete:* Concrete which contains defective areas too large to be repaired as described above shall be cut to the far face of surface reinforcement or further if necessary to remove all the defective material, and the edges undercut. The fresh concrete surface shall then be cleaned, washed down and thoroughly soaked with water until the concrete becomes saturated. The concrete surface should be damp. Finally the hole shall be filled with concrete which may incorporate a non-shrink agent approved by the Employer.
 - 8) Concrete which will be exposed to view shall be repaired in a manner which will result in a concrete surface with a uniform appearance.

5.17.2 Dry-Pack Mortar

- 1) The dry-pack mortar shall consist of 1 part cement to 2½ parts of sand, by volume, that will pass a US Standard Sieve No. 16 (1.18 mm). Only enough water shall be used to produce a mortar which will stick together when moulded into a ball by a slight pressure of the hands and will not exude water but will leave the dry-pack in thin layers.
- 2) Dry-pack mortar shall be placed and packed in layers. Each layer shall be solidly compacted over its surface by use of a hardwood stock and hammer.
- 3) Dry-pack mortar shall be used for filling holes having at least one surface dimension less than the hole depth, for narrow slots cut for repair of cracks, for re-drilled grout holes and grout pipe recesses, and for tie-rod fastener recesses.
- 4) Dry-pack mortar shall not be used for filling behind reinforcement or for filling holes that extend completely through the concrete section.

5.17.3 Mortar Filling

- 1) Mortar to be used for repair work shall have the same sand, cement and air proportions as the mortar in the mix of the concrete to be repaired but no coarse aggregates. The Contractor shall place mortar filling with a mortar gun or by hand.
- 2) Mortar filling shall be used to repair defects which are too wide for dry-pack filling and too shallow for concrete filling and no deeper than the far side of the reinforcement that is nearest the surface.
- 3) Mortar filling in concrete surfaces destined to be in contact with flowing water shall be used only together with the application of epoxy materials using a procedure approved by the Employer.

5.17.4 Concrete Filling

- 1) Concrete filling shall be used for holes extending entirely through concrete sections, for holes in which no reinforcement is encountered and which are greater in area than 0.1 m² and deeper than 100 mm and for holes in reinforced concrete which are greater in area than 0.05 m². Holes in reinforced concrete which extend beyond the reinforcement shall be enlarged as necessary to permit satisfactory filling of the hole with concrete.
- 2) Concrete filling shall be tightly packed and completely bonded to the surfaces of the holes. The mix proportions of the filling materials shall be such as to provide a strong, dense repair which will avoid colour variations in surfaces exposed to view.
- 3) On surfaces permanently exposed to view, and where required by the Employer, the Contractor shall supply white cement in sufficient amount, as determined by trial, which when blended with normal cement, will produce a finish of similar appearance to the adjacent concrete. Non-shrink agent shall be used where a watertight joint is required. The surface of patches shall be smooth and flush with the surrounding concrete.

5.17.5 Epoxy-Resin Bonding

- 1) Any repairs made after 7 days after the original concrete placement for thicknesses less than 25 cm thick shall utilise epoxy-resin bonding system. The locations where epoxy-resin will be used will be determined by the Employer, who will approve the type and brand to be used.
- 2) The method of repair shall be as recommended by the manufacturer. The product used may contain no toxic compounds.
- 3) In areas exposed to public view, the concrete surfaces repaired with epoxy-resin bonded system shall be lightly ground to eliminate gloss of the finished epoxy mortar surface and to produce a surface colour and texture that closely matches the surrounding concrete surface.

5.17.6 Stains and Discoloration

Stains or discoloration of exposed (Class F2, F2C and U2) concrete surfaces shall be removed. The procedure or method of removing the stains and/or discoloration will be subject to approval. The removal of stains or discoloration shall not be started until the work that originally caused the stains or discoloration is completed.

5.18 Particular Requirements

5.18.1 General

- 1) The levels of the floors in the powerhouse, sluiceway and navigation locks and the dimensions of the concrete elements such as beams, columns, floors, walls and openings as shown on the Tender Drawings are typical only and may be changed in the final design to suit the actual shapes and sizes of the equipment to be installed in the powerhouse.
- 2) Blockouts, holes, pipes, pits, pedestals and embedded metalwork for equipment, cables, anchor bolts and other accessories are not fully detailed on the Tender Drawings and may be changed in number, location or size on the Construction Drawings.
- 3) The Contractor shall cooperate closely with the supplier of the mechanical and electrical equipment during equipment installation and its embedment, including provision of bracing and ties necessary to maintain all equipment in their correct position during placement of the surrounding concrete.

5.18.2 Embedding of Equipment

- 1) Parts of the equipment to be installed in the powerhouse, sluiceway and navigation locks shall be encased in concrete, and the first stage concrete shall be formed to the openings required for the installation of the equipment. As the installation of the equipment proceeds and the second stage concrete is required to be placed around the equipment, or any part thereof, the Contractor shall place the reinforcement and concrete as shown on the Construction Drawings.

- 2) The manner of placing concrete on or against such equipment, including the precautions necessary to ensure sound contact between the concrete and the equipment and to avoid disturbing the position of the equipment, shall be subject to the approval of the Employer.
- 3) The Contractor shall construct erection pedestals for placing and aligning the stay rings, draft tubes and other equipment units in the powerhouse, and provide setting anchors, reinforcing steel, and dowels as indicated by the equipment suppliers or as directed by the Employer. The units to be embedded shall be checked for alignment immediately before, during and after concrete placing operations.
- 4) Second stage concrete shall be placed in a continuous monolithic pour in layers not exceeding 0.5 m per hour. Concrete vibrators shall not be used within 0.5 m of the stay ring, draft tube and other equipment units or supports.
- 5) Unless otherwise specified or shown on the Construction Drawings, concrete class 30/25 with the addition of an approved non-shrink agent shall be used for embedding of equipment in second stage concrete. However, the Employer may order certain part of the second stage concrete to be executed as class 30/19.
- 6) Any pipes used to fill or grout the space remaining beneath the stay ring or draft tube shall be supported independently and not welded to the equipment.

5.18.3 Contact Grouting between Concrete and Stay-Ring, Draft Tube, Steel Linings and Other Embedded Components

- 1) At any point where an inspection (e.g. by a knocking test) indicates that a cavity exists between steel liners and the surrounding concrete, as determined by the Employer, the Contractor shall drill and tap the liners to provide grouting points.
- 2) Tapped holes for grouting, complete with threaded steel plugs, will be provided. The Contractor shall provide threaded pipes to protect the thread of the grouting hole during the drilling and grouting operation.
- 3) Grouting of this type shall not commence until the backfill concrete has been in place for at least 28 days.
- 4) Low pressure contact grouting shall be carried out until all voids are thoroughly filled. The maximum grouting pressure shall be 5 bars or as directed by the Employer, and the Contractor shall ensure that the specified pressure is not exceeded.
- 5) After completion of grouting, the Contractor shall clean the threaded holes and screw the plugs back into position. The plugs will be welded permanently into the steel lining and the plug heads ground off flush. When this work is complete the Contractor shall thoroughly clean and protect against corrosion the damaged steel lining surface.
- 6) After completion of grouting, a knocking test shall be performed jointly by the Contractor and the Employer to establish if contact grouting between the steel component and concrete has been completely successful. If a "hollow" sound indicates the grouting to be in-complete, the Contractor shall re-grout, which may include the drilling, tapping and sub-subsequent sealing of additional holes by others.

5.18.4 Concrete in Blockouts for Embedding Equipment

- 1) The Contractor shall form blockouts, place reinforcement and concrete as shown on the Construction Drawings or as directed by the Employer, and in such manner as to ensure good bond with the existing concrete, to secure complete contact with the metalwork to be embedded in the breakout concrete and to avoid displacement of the metalwork.
- 2) Breakout concrete excludes concrete designated on the Construction Drawings or by the Employer as second stage concrete.
- 3) Except as otherwise specified the hydromechanical, mechanical, and electrical equipment will be provided and installed by the suppliers in cooperation with the Contractor.
- 4) Before placing concrete, all parts to be embedded shall be checked to ensure that they are firmly fixed in their required position. The surfaces of blockouts or holes shall be thoroughly cleaned and wetted. Oil or grease shall be removed by brushing and chipping of affected surfaces to a sufficient depth, or by application of approved chemicals and flushed with clear water.
- 5) The parts to be embedded shall be cleaned of rust, mill scale, paint, oil or grease before they are set into place. Where bond between metal parts and concrete or grout is not desired, approved material such as flake graphite or paraffin shall be applied to the metal parts. The metal surfaces shall be wetted before placing the concrete or grout.
- 6) Unless otherwise specified or shown on the Construction Drawings the concrete classes 30/19 and 30/25 containing an approved nonshrink agent shall be used for concrete in blockouts for equipment embedding.

5.18.5 Grouting of the Equipment Bearing Plates and Anchors

- 1) Limited spaces and small blockouts where equipment bearing plates, anchors, rails, etc., are placed shall be grouted under pressure.
- 2) The grouting shall be performed using non-shrink cement-based grout or non-shrink epoxy grout as proposed by the Contractor and approved. All mixing and grouting shall be performed in accordance with the manufacturer's recommendations and shall be tested prior to grouting. Technical service by the manufacturer shall be organised by the Contractor upon request by the Employer.
- 3) Before placing grout, the surfaces of the base concrete to which the grout will be bonded shall be roughened and cleaned of all laitance, loose or defective concrete, any coatings or other foreign material, followed by thorough washing with water. Forms for grouting shall be installed where necessary and care shall be taken that the grout fill all spaces under the plates leaving no voids. The exposed surfaces of the grout shall be cured as recommended by the manufacturer and no loads shall be applied until the grout has reached the design strength.

5.18.6 Allowance for Floor Finishes

- 1) Concrete slabs to be covered with a floor finish or tiles shall be left at a sufficient depth below the finished floor elevations to permit placing of the required thickness of floor finish or tiles, and proper allowance shall be made for the finish when anchor bolts, pipes and other metalwork are placed.
- 2) Concrete slabs forming floors shall be carefully screeded to the design levels shown on the Construction Drawings. Scabbling or grinding to bring the floor to the correct levels will not be permitted after installation of mechanical or electrical equipment has commenced.

5.18.7 Vertical Connection with Two Phases Slurry Trench Cut-off Wall

- 1) Connection of the plastic concrete diaphragm wall and the structure shall be as shown on the Drawings, see Album Drawing No. 71.
- 2) Casting sequences and removal of formwork of the vertical plastic concrete connecting beam shall immediately precede backfilling against the abutment wall so that the vertical plastic concrete connecting beam is exposed for the shortest possible period. Placing lifts for the vertical plastic concrete connecting beam shall be in accordance with the construction drawings and should be approximately 3 m.
- 3) The vertical plastic concrete connecting beam shall have a footing wider than the typical section, as shown on the construction drawings.
- 4) The plastic concrete mix and placing methods shall comply with the requirements of Section 4, "Two Phases Slurry Trench Cut-off Wall under the Permanent Structures".
- 5) Particular care shall be taken to ensure adequate bonding of material when compacting the fill against the vertical plastic concrete connecting beam: the requirements of Section 1.5.2, "Backfill and Embankment" will apply.

5.18.8 Public Road Bridge Deck

Public road bridge deck construction shall comply with the requirements of ACI 345R: Guide for Highway Bridge Deck Construction.

5.19 Precast Concrete

- 1) The Contractor shall investigate the possibility of obtaining and utilising the standard precast concrete products available on the local market, prior to commencement of any such production on his own.
- 2) When producing on his own, the precast concrete units shall be manufactured and cured in a properly equipped casting yard or shop. The facilities shall be subject to inspection and approval by the Employer.

- 3) The quality of materials used in manufacture of the precast concrete units shall conform to the applicable requirements contained in these Specifications.
- 4) Details of the design, concrete components and mixes, and test results shall be made available to the Employer.
- 5) Precast units which will be used in composite construction shall contain interlocking devices welded or formed into the steel member for connection with the subsequently cast in situ concrete to prevent a slip between the two materials and normal steel reinforcement. Such connections shall be designed so that they can resist 1.8 times the working load to which they will be subjected and that the ensuing movements cause no distress to the joint. The Contractor shall submit design details and calculations for approval before commencing any production.
- 6) Care shall be taken during storage, hoisting, and handling of the precast units to prevent cracking or damage. Units damaged by improper storing or handling shall be replaced by the Contractor.

5.20 Measurement and Payment

5.20.1 Quality Control and Testing

- 1) All costs associated with Quality Control, submittals and testing as specified in this Section shall be borne by the Contractor, who shall make allowance for all such costs in the unit prices for the concrete work. These shall include, but not necessarily be limited to, the following:
 - a) The costs for all tests to be carried out during proportioning and studying trial mixes prior to the start of concrete work and subsequently, whether carried out at site or elsewhere.
 - b) Quality Control routine tests during the execution of the concrete work carried out by the Contractor as specified herein and as directed.
 - c) Other tests specified during execution of the work to be carried out by an approved test laboratory(ies).
 - d) Preparation, storage, handling, curing and delivery of samples to a laboratory designated by the Employer, if so required for additional independent testing.
 - e) Assistance to the Employer when specimens will be tested by the Employer.
 - f) Reporting for all tests as required in these Specifications in accordance with Standard Specifications.
- 2) Should the Contractor fail to adhere to his Quality Control Plan, all tests deemed necessary by the Employer to check concrete work will be performed by the Employer or a laboratory assigned by him, at the Contractor's expense.
- 3) All tests specified herein or required from Standard Specifications carried out at independent external laboratories will be paid for by the Contractor.

5.20.2 Concrete

5.20.2.1 General

- 1) Measurement for payment for each class of concrete, unless specified otherwise hereafter, will be of the volume placed within the lines, grades, and pay-limits shown on the Construction Drawings or as established at the site by the Employer.
- 2) Unless otherwise stated, no payment will be made for concrete placed outside these limits, other than in additional excavation directed by the Employer.
- 3) Payment will be made at the unit prices for different classes and types of concrete entered in the Schedule. These unit prices shall include, but not be limited to, all costs for the following works:
 - a) Excavation, loading, transportation, crushing, screening, washing, blending, and storage of aggregates, including the stripping and removal of overburden from borrow areas, all costs of dealing with water in borrow areas, and all installations and equipment.
 - b) Supply and transport of concrete materials (including air-entraining, water-reducing/set-controlling admixtures), batching, supply of mixing water, mixing, transportation, placing, and consolidation of the concrete, including all installations and equipment, and the costs of placing concrete around steel reinforcement.
 - c) Labour, tools and equipment for cleaning, and preparing surfaces prior to concreting.
 - d) Forming and treatment of construction joints including furnishing and spreading of mortar layers, or starter mixes before concrete placing.
 - e) Maintaining the concrete temperature as specified, and hot weather concreting requirements.
 - f) Protection and curing of placed concrete, including hot weather requirements.
 - g) Repair or replacement of defective concrete.
 - h) Communication systems connecting the points of placing concrete with the relevant mixing plant or delivery equipment.
 - i) Removal and disposal of waste ingredients, concrete and test samples.

5.20.2.2 Second Stage Concrete and Concrete in Blockouts for Equipment Embedding

- 1) Measurement for payment of second stage concrete and concrete in blockouts will be for the specified concrete class by the volume of placed concrete. Only second stage concrete placed in spaces exceeding 1.5 m² in cross section will be considered for payment. Concrete placed in blockouts or spaces less than stated above shall be deemed to be included in the unit price for concrete in the structure with which it is associated.
- 2) Payment will be made at the unit price "per cubic meter" entered in the Schedule, which shall include, in addition to works included under "General" above, the entire cost of preparation of contact surfaces with parent concrete, furnishing of all admixtures, contact grouting as specified in Section 5.18.3 and any other related work.

5.20.2.3 Grouting of Equipment Bearing Plates and Anchors

- 1) Measurement for payment for the non-shrink cement-based and epoxy-based grout will be of the actual volume placed in the blockouts and under bearing plates.
- 2) Payment will be made at the appropriate unit price "per unit volume" entered in the Schedule which shall include, in addition to works included under "General", the entire cost of preparation of contact surfaces with parent concrete, furnishing of all admixtures and any other related work. Technical service rendered by the manufacturer as needed, will not be separately reimbursed but is deemed to be included in the unit prices.

5.20.2.4 Precast Concrete

- 1) Measurement for payment for precast concrete units will be by the volume in cubic meters of the units placed, as determined from the Construction Drawings.
- 2) Payment will be made at the appropriate unit price "per cubic meter" entered in the Schedule, which shall include, in addition to works described under "General", the entire cost of formwork, cement, admixtures, reinforcing steel, storage, transportation, and erection.

5.20.3 Steel Reinforcement

- 1) Measurement for payment for reinforcing bars will be of the weight of reinforcing steel, including splices, as stated in the approved bar lists. The weight entered in the bar lists will be computed using the nominal weight per linear meter of different bar diameters based on the specific weight of 7,850 kg/m³.
- 2) Unless otherwise approved in advance by the Employer, mechanical connections shall be paid the equivalent of the substituted splice.
- 3) Payment will be made at the unit price "per metric ton" entered in the Schedule, which shall include the entire cost of supply, storage, cutting, bending, placing,

connecting, wire clips, ties, separators, welding of the crossing points where required and any other fastening devices.

- 4) Measurement for payment for welded wire fabric placed in concrete structures will be of the weight as stated in the approved bar lists. Payment will be made at the unit price "per metric ton" entered in the Schedule. The weight will be computed using the nominal unit weight per square meter as stated on the certified copies of manufacturer's reports which the Contractor has submitted to the Employer or, in absence of such reports, by direct measuring at the site.
- 5) No extra payment will be made for the following:
 - a) Wire for tying reinforcement.
 - b) Reinforcement and pre-stressing steel in pre-cast and pre-cast pre-stressed concrete units, and the cost thereof shall be included in the applicable unit prices for such concrete elements.
 - c) Any additional reinforcement or splices required when Contractor's casting sequences differ from construction joints shown on the Construction Drawings.
 - d) Any reinforcing steel placed by the Contractor for his own convenience in addition to those shown on the Construction Drawings and entered in the bar lists.
 - e) Any reinforcing steel delivered for testing.

5.20.4 Formwork

- 1) Measurement for payment for formwork will be of the formed area for the class of formwork shown on the Construction Drawings.
- 2) Payment will be made at the unit prices "per square meter" entered in the Schedule for various classes of flat and curved formwork, which shall include the entire cost of design, provision, transportation, storage, maintenance, oiling, cutting, erection, all necessary ties and fixings, access scaffoldings, forming of chamfers up to 500 mm² either internal or external and edges up to 50 mm width.
- 3) Openings in the forms for blockouts, niches, etc., which area is smaller than 0.05 m² will not be deducted from the area measured for payment.
- 4) Measurement for payment for formwork used to form contraction and expansion joints will be made of the flat area in square meters of joints shown on the Construction Drawings. No extra payment will be made for shear key boxes shown on the Construction Drawings or for joints which the Contractor adds for his own convenience.

5) No extra payment will be made for the following:

- a) Any kind of construction joints.
- b) Formwork used for manufacturing of pre-cast and pre-cast pre-stressed concrete units.
- c) Any forms rejected by the Employer.

The cost thereof shall be included in the applicable unit price for concrete in the structure with which it is associated.

5.20.5 Unformed Surface Finishes

- 1) Measurement for payment for unformed surface finishes will be of the area for the class of finish shown on the Construction Drawings.
- 2) Payment will be made at the unit prices "per square meter" entered in the Schedule for various classes of unformed finishes, which shall include for each class the entire cost of the work until the specified class is complied with. The unit prices for unformed surfaces are not cumulative.
- 3) Measurement for payment for unformed surfaces of the sluiceway weir reaching a slope of up to 30 degrees will be made of the horizontal area in square meters shown on the Construction Drawings.

5.20.6 Expansion Joints

- 1) Measurement for payment will be made for the following items in the units stated:
 - a) Elastomeric waterstop per linear meter placed.
 - b) Joint sealing cord per linear meter placed.
 - c) Joint filler panels per square meter.
 - d) Bituminous coating per square meter (2 coats included).
- 2) Payment will be made at the appropriate unit price entered in the Schedule, which shall include the entire cost of all materials, plant and labour for furnishing and constructing expansion joints as specified, and all temporary protection of the joints from damage.
- 3) Payment will only be made for the expansion joints shown on the Construction Drawings or directed by the Employer. Additional joints for Contractor's convenience may be approved by the Employer, but no payment will be made for materials used in such joints.

5.20.7 Vertical Connection with Two Phases Slurry Trench Cut-off Wall

Measurement and payment for casting the vertical connection beam with plastic concrete will be made at the appropriate unit price “per cubic meter” entered in the Schedule for the connection of the diaphragm wall to the structures. The installation of elastic filler, waterstops, etc. will be paid separately under appropriate payment items of the Schedule.

5.20.8 Steel Dowels

Supply and placing of steel dowels will be paid per ton of dowel actually placed; the unit price to include also all costs of drilling holes for the dowels, cutting and bending of dowels, providing grout materials and filling the drillholes, and testing the installed dowels. The unit price per ton is to cover all diameters and lengths of dowels which may be specified.

5.20.9 Exclusions

No extra payment will be made for the following:

- a) Any rounded or bevelled edges, fillets, scoring, chamfers, or any deduction made for voids or embedded items which are either less than 0.01 m³ in volume or 0.05 m² in cross section; no allowance will be made for approved temporary openings, drains, embedded pipes, or recesses created by the Contractor for his own convenience during construction provided they are filled as directed.
- b) Any collecting of seepage water or water inflow and diverting it into the drainage systems specified in Section 3, “Temporary Cofferdams and Construction Pit Excavation and Dewatering”.
- c) Any defective and wasted concrete and concrete ingredients; concrete which has to be removed and replaced due to Contractor's non-compliance with the Specifications or Employer 's directions, and all related cost shall be at the Contractor's expense.
- d) Any concrete which the Contractor places or uses for his own installations or for his own convenience.
- e) Developing sources of aggregates by the Contractor and the resulting materials testing.
- f) Pumping of the concrete.
- g) Any pre-cast and pre-cast pre-stressed concrete units damaged by improper manufacture, storing, handling or transportation.
- h) Any temperature gauge, related instrumentation, supply and installation, recording and reporting, as specified for measurement and control of concrete temperature.
- i) Any contact grouting and re-grouting behind steel linings and other embedded components, including those associated with the drilling, tapping, sealing of holes and restoring protection against corrosion of the surface.

- j) Any concrete placed under water. Should such work be ordered by the Employer, the additional cost will be estimated and paid at the prices of the Daywork Rates Schedule.
- k) Any material cost, treating and installing waterstops at any construction joints or connection to expansion joints, irrespective of the treatment method and waterstop type used.

5.21 Tables

Table 5.1: Frequency of Aggregate Testing

Test Description	Standard	Frequency
COARSE AGGREGATE		
Moisture Content	ASTM C70 or DIN 4226-3	A test for moisture content of each size of coarse aggregate shall be made at least once every working day. When two consecutive readings for small size aggregate differ by more than 1.0%, frequency of testing shall be increased to that specified for fine aggregate below.
Gradation	ASTM C136 or DIN 4226	Once during each shift in which the concrete plant is operating, there shall be a sieve analysis for each size of coarse aggregate. Samples shall be taken from the batch plant bins. Each test record shall show the results of the current test as well as the average result of the five most recent tests including the current test.
Amount of Material finer than No. 200 (75 micron) Sieve	ASTM C117 or DIN 4226	Testing frequency shall not be less than one per day.
Soundness	ASTM C88 or DIN 4226	Per 10,000 m ³ of concrete or as directed by the Employer.
Particle Shape Analysis	CRD-C 119	When, in the opinion of the Employer, a problem exists in relation with particle shape. Then, testing frequency shall not be less than one per day.
Clay Lumps and Friable Particles	ASTM C142	Ditto.
Lightweight Pieces in Aggregate	ASTM C123	Ditto.
Alkali Reactivity	ASTM C289	Per 10,000 m ³ of concrete.
Petrographic Analysis	Designation 7 of USBR Concrete Manual	Ditto.
Specific Gravity of Coarse Aggregate	ASTM C127 or DIN 4227	In early stages of work, and when changes in aggregate, but not less than every 10,000 m ³ of concrete.

Table 5.1 (continued): Frequency of Aggregate Testing

Test Description	Standard	Frequency
FINE AGGREGATE		
Moisture Content	ASTM C70 or DIN 4226-3	There shall be, when in the opinion of the Employer, the specified electric moisture meter is not operating satisfactorily, at least two pairs of tests for moisture content during each 8-hour period of mixing plant operation. The two tests in each pair shall be spaced one hour apart and the times for the pairs shall be selected randomly within the 8-hour period. An additional test shall be made whenever the slump is shown to be out of control or excessive variation in consistency is reported by the placing foreman. When the electric moisture meter is operating satisfactorily, at least one direct measurement of moisture content shall be made per week to check the calibration of the meter. Variability within one-hour or 8-hour period may be determined by meter readings.
Gradation	ASTM C136 or DIN 4226	Once during each working day when the concrete plant is operating. The sampling location may be selected by the Employer.
Amount of Material finer than 75 microns Sieve	ASTM C117 or DIN 4226	Ditto.
Fineness Modulus	Designation 4 of USBR Concrete Manual	Ditto.
Sand Equivalent	ASTM D2419	Once 3 tests during each day when the concrete plant is operating. There shall be one sand equivalent test for each category of fine aggregate, if appropriate.
Organic Impurities	ASTM C40 or DIN 4226-3	Per 2,000 m ³ of concrete.
Soundness	ASTM C88 or DIN 4226	Ditto.
Particle Shape Analysis	CRD-C 119	When, in the opinion of the Employer, a problem exists in relation with particle shape. Then, testing frequency shall not be less than one per day.
Clay Lumps and Friable Particles	ASTM C142	Ditto.
Lightweight Pieces	ASTM C123	Ditto.
Alkali Reactivity	ASTM C289	Per 10,000 m ³ of concrete.
Petrographic Analysis	Designation 7 of USBR Concrete Manual	Ditto.
Specific Gravity	ASTM C128 or DIN 4226	In early stage of work, and when changes in aggregate, but not less than every 10,000 m ³ of concrete.

Table 5.2: Concrete Classes

Concrete Class	Specified Design Strength	Maximum Aggregate Size	Application
15/25	15 MPa	25 mm	Blinding concrete
25/50	25 MPa	50 mm	Mass concrete
30/19	30 MPa	19 mm	Second stage concrete for cross-sectional areas not larger than 1.5 m ²
30/25	30 MPa	25 mm	Structural concrete for members smaller than 2 m thick
35/25	35 MPa	25 mm	Selected structural elements with higher stress
35/19	35 MPa	19 mm	Precast elements
30/25	30 MPa	25 mm	Second stage concrete for cross-sectional areas larger than 1.5 m ²

Table 5.3 - Cementitious Blend Specifications for Mass Concrete

Characteristic	Value	Test Method
Minimum compressive strength at 90 days	25 MPa	ASTM C109
Initial setting time (Vicat needle) more than	90 min	ASTM C191 or DIN EN 196-3
Initial setting time (Vicat needle) less than	180 min	ASTM C191 or DIN EN 196-3
Le Chatelier stability - cold and hot expansion less than	3 min	NFP 15-473
Shrinkage at 28 days of mortar less than	0.08%	ASTM C596
Chemical characteristics SO ₃ less than	5%	ASTM C114 or DIN EN 196-2
Heat of hydration at 5 days for elements in contact with water	200 J/g	NFP 15-436 or DIN 1164-8
Heat of hydration at 5 days for elements not in contact with water	250 J/g	NFP 15-436 or DIN 1164-8
Equivalent sodium oxide (Na ₂ O+0.658K ₂ O) less than	0.6%	ASTM C114 or DIN EN 196-2
Potential Alkali reactivity of cementitious materials – aggregates combination - expansion at:		
- 6 months, less than	0.075%	ASTM C227
- 12 months, less than	0.1%	ASTM C227
Maximum CaO content	45%	
The cement used for reinforced concrete shall not contain more than 0.15% chloride.		

Structure	Reinforcement	Concrete	Reinforcement Content
	to	m3	kg/m3
Powerhouse			
Abutment Pier			
U/S-Part 1	442,9	4.025,0	110,0
Support Towers U/S-Part 1	8,0		
U/S-Part 2	217,8	2.180,0	99,9
Support Towers U/S-Part 2	1,9		
Axis 1-2/A-G	2.665,0	20.075,0	132,8
Support Towers Middle Part	37,9		
D/S-Part			
Foundation Slab	232,5	1.951,0	119,2
Support Towers D/S-Part	19,3		9,9
Walls and Slabs	639,5	4.629,0	138,2
Σ PH Abutment Pier	4.264,8	32.860,0	129,8
D/S-Slab	148,4	1.732,0	85,7
Unit 1 - 4			
Unit 1+2			
Foundation Slab	1.805,8	11.505,0	157,0
Support Towers Unit 1+2	78,4		6,8
Walls and Slabs	3.803,0	20.440,0	186,1
Σ Unit 1+2	5.687,2	31.945,0	178,0
Unit 3+4			
Foundation Slab	1.820,8	11.505,0	158,3
Support Towers Unit 3+4	78,4		6,8
Walls and Slabs	2.560,0	20.440,0	125,2
Σ Unit 3+4	4.459,2	31.945,0	139,6
Crane Beam Ext. + St.Chamber	70,4	480,0	146,7
Sluiceway			
Intermediate Pier, U/S-Part	341,7	3.955,0	86,4
Intermediate Pier, Axis 6-8/A-H	3.135,7	22.785,0	137,6
Support Towers (Middle+U/S)	59,9		
Intermediate Pier, D/S-Part			
Foundation Slab	158,3	1.490,9	106,2
Support Towers D/S-Part	15,0		10,1
Walls and Slabs	412,4	2.959,2	139,4
Σ Intermediate Pier	4.123,0	31.190,1	132,2
Sluiceway	4.558,9		
Foundation Slab		32.000,0	
Support Towers	332,9		10,4
Piers		20.620,0	
Σ Sluiceway	4.891,8	52.620,0	93,0
Sluiceway, D/S-Slab	816,2	8.940,0	91,3
Abutment Pier			
Axis 15-17/A-H	2.123,2	15.445,0	137,5
Support Towers	61,9		
Abutment Pier, D/S-Part			
Foundation Slab	101,4	880,0	115,2
Support Towers D/S-Part	8,5		9,7
Walls and Slabs	392,4	3.286,0	119,4
Σ SW Abutment Pier	2.687,4	19.611,0	137,0
Service Bridge	62,1	322,0	192,9
Main Gantry Crane Bridge	165,4	818,0	202,2
Navigation Lock			
U/S-Head, Axis K-L/19-22			
Support Towers	29,2		
Foundation Slab, Slabs, Walls	1.294,2	13.540,0	95,6
Σ U/S-Head	1.323,4	13.540,0	97,7
Middle Part, Axis L-S/19-22, L=25.5m			
Foundation Slab	2.116,8	26.026,4	81,3
Support Towers	161,9		6,2
Walls and Slabs	1.894,8	20.213,4	93,7
Σ Middle Part	4.173,5	46.239,8	90,3
D/S-Head			
Support Towers	80,7		1,4
Foundation Slab till +52.90 (58.40)	8.209,2	56.777,3	144,6
Walls and Slabs	3.686,7	29.971,0	123,0
Σ D/S-Head	11.976,6	86.748,3	138,1
Control- and Guard Tower	56,5	310,0	182,3
U/S - D/S additional Structures			
U/S - D/S Middle Pier	311,3	2.570,0	121,1
U/S - D/S Guide Wall	701,8	11.040,0	63,6
U/S Retaining Wall		460,0	
D/S Retaining Wall		2.680,0	
U/S - D/S Retaining Wall	271,5	3.140,0	86,5
Fender Mounting Posts (31pieces)	3,3	30,0	110,0
Σ add. Structures	1.287,9	16.780,0	76,8
Public Road Bridge (incl. Piers+Abutm.)	704,7	3.265,0	215,8
PH+SW-Guard Tower, Int.-Pier Stairc.Shaft, PH-Supply House at axis A/1	23,5	150,0	2,9
Concrete Hatch Covers	11,7	170,0	68,8
SW-Aux.Bldg.,	16,1	145,0	111,0
Service Area (Cable Trench., Distr.Str.)	178,0	1.080,0	164,8
Capping Cut Off Wall			
COW PH-Abutment Pier (incl. vertical part):		376,7	
COW PH-Unit 1-4:		559,3	
COW SW-Int.-Pier:		210,9	
COW SW:		1.129,7	
COW SW-Abutm.-Pier:		173,8	
COW NL (incl. vertical part):		784,7	
Σ Capping COW	227,9	3.235,1	70,4
CLR	394,0		
Overall Summarizing:	47.749,7	384.126,3	124,3

B	17.01. 2004	A. Poller	M. Heinisch	R. Eymery	Revised as per NHBDC comments. Ref.: AS-00-1045.1
A	19.12. 2004	A. Poller	R. Eymery	F. Guinchard	First issue
Ind.	Date	Prepared	Reviewed	Approved	Description

ARAB REPUBLIC OF EGYPT
MINISTRY OF WATER RESOURCES AND IRRIGATION (MWRI)
MINISTRY OF ELECTRICITY AND ENERGY (MEE)
HYDRO-POWER PLANTS EXECUTIVE AUTHORITY (HPPEA)

Naga Hammadi Barrage Development Consultants (NHBDC)

NEW NAGA HAMMADI BARRAGE AND HYDROPOWER PLANT

Lot 1 – Civil Works

Approval Stamp:

MWRI / NHBDC		
Document Review		
Document No:	Approval Sheet No:	
A	Approval	
AN	Approval except as Noted	
RR	Returned for correction and Resubmission	
	name	date
Checked:		
Approved:		
The approval of the documents will not exonerate the Contractor from any responsibility in connection with the works.		

Status stamp:

Project Document No. : NH 01 05 R 143 / B

Naga Hammadi Barrage Joint Venture (NHB-JV)



Method Statement Reinforcement Placing and Fixing

Originator:

NHB JV

First issue date:

Page No. 1 of 11

Reference

Identification Number

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1 Introduction

This method statement describes the detailed steps of placing and fixing of reinforcement for concrete structures.

2 Reference Documents

2.1 Contractual Documents

Particular Technical Specifications

- Vol. 3, Part II, Section 5 “ Concrete”

2.2 Other Documents

This document shall be read in conjunction with the latest revision of the following documents:

- Related concrete outline drawings Type (C)
- Related rebar drawings Type (R)
- Related embedded part drawings Type (S)
- Method statement for Concrete Placing NH01 P 00 JV MSP 1046
- Method statement for Reinforcement cutting and bending NH01 P 00 JV MSP 1060
- MSF for Pre-cast Concrete Spacers NH01 P 00 JV MSF 1068
- MSF for Binding Wire NH01 P 00 JV MSF 1071

3 Resources

3.1 Equipment

3.1.1 Equipment List

Type	Quantity
• Tower Cranes	8 Pcs
• Trailer + Tractor	2 Pcs

3.2 Personnel

For one team:

- 1 Foreman
- 2 Headman
- 2 Teams @ 10 Workers per team

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4 Materials

Type	Remark
• Reinforcement	Grade 40 / 60
• Binding wire	ES 262 / 88, acc. MSF
• Concrete Spacer	Acc. MSF

5 Execution Instructions

5.1 Equipment Preparation

5.2 Preparation, Transportation, Site Storage

The transportation of rebar has to be carried out by trailer. The reinforcement will be placed either directly in the area of placing or in an intermediate site storage.

Reinforcement shall be lifted by using tie slings in good condition with sufficient capacity. To avoid the slipping of slings timber shall be put between the slings and bars.

Before storing bars, supporting beams made of steel, timber or precast concrete shall be placed to avoid pollution of bars by soil.

Care shall be taken not to loose or damage the labels, which can create difficulties to identify the right bar marks.

The numbers, shapes and length of bars has to be checked by the supervisor before placing.

5.3 Logistic Information

All orders for transportation and equipment have to be issued at least 24 hours in advance to the rebar yard.

The processing of bars will be carried out according the 3 months programme and weekly coordination by the site management.

5.4 Responsibilities

Site Engineer

- Preparation of RFI and Daily Reports, Follow up the ICL
- Supervision of works
- Material and Equipment order

Foreman:

- Supervision of the team

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5.5 Work Sequence

5.5.1 Setting Out

Before placing of reinforcement, the main axis and concrete outlines as well as elevated structures, embedded parts and the spacing of the first reinforcement layer have to be marked on the formwork or concrete surface.

5.5.2 Preparations

The following preparations have to be carried out before the placing and fixing works can start

- Cleaning and adjusting of existing starter bars
- Preparation of construction joints and cleaning of waterstops
- Preparation of working platforms for working in height

5.5.3 Spacers

Sufficient precast concrete spacers have to be placed and fixed in the intersection of crossing bars to avoid deflection of bars in the first layer during the increase of load coming from the intermediate and top reinforcement layers. The minimum number is four spacers per m².

5.5.4 Bottom Layers

The bottom layers of reinforcement contending up to eight crossing single layers of reinforcement.

After placing the spacers the first layer of rebar shall be placed and temporary fixed with supporting bars.

The spacing of the next layer will be marked and the bars placed and fixed. In this sequence each layer has to be finished up to the last layer of bottom reinforcement.

Where shown in the construction design, starter bars and shear have to be placed simultaneously to the reinforcement layers where they have to be incorporated.

5.5.5 Starter Bars

Starter bars for the next lift or elevated structural parts have to be placed according the marked concrete outlines with the required distance of concrete cover.

In areas where starter bars have to be fixed in the intermediate or top layers, the setting out of concrete outlines has to be carried out before fixing of bars.

Where starter bars are longer than 7.5 m, the bars have to be kept in position by placing supporting structures or shoring according the site needs.

Construction bars for temporary fixing have to be removed before placing concrete.

5.5.6 Intermediate Layer

The intermediate layers contend the support towers or chairs, cubic or spatial reinforcement.

Those rebar's have to be placed after finishing the bottom layer and placing the construction joint formwork panels.

The towers have to be prefabricated and lifted in the right location by tower crane. Horizontal bars have to be fixed on the horizontal tower bars. Chairs have to be fixed properly on the bottom reinforcement.

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5.5.7 Embedded Parts

Particular care shall be taken where embedded parts or waterstops have been installed before or have to be installed after placing the reinforcement.

Waterstops must be cleaned from binding wire carefully and the location of embeddings has to be checked before casting concrete regarding displacement during reinforcement works.

5.5.8 Construction Joints

In the construction joint areas, the reinforcement is crossing the formwork.

The expanded metal sheet formwork allows the installation of penetrating rebar's without problems. The holes in the expanded metal sheets for the crossing bars have to be marked on the sheets and punched by hand, using hammer and short steel bars.

5.5.9 Top Layers

The top layers of reinforcement shall be placed after finishing the intermediate layers. Before the work starts, the bottom layer shall be cleaned and inspected by the site engineer.

The top reinforcement shall be placed in accordance to the construction drawings. Where the pour height is more than 1.5 m, concreting openings with a clearance of 25 cm x 25 cm in a grid of 3m x 3m have to be prepared. To access the bottom area for cleaning and wetting at least one opening 75 cm x 75 cm per concrete section shall be prepared.

5.5.10 Elevations

In elevated structural parts such as walls and piers the reinforcement work starts after finishing the placing of the advanced formwork.

Depending on the thickness of the structure the working platform for rebar works can be installed either between the outer and inner forms or on the climbing platform.

Where the formwork has to be closed after finishing of reinforcement works, the inspections have to be carried out before closing in the sequence of rebar placing and finishing.

5.5.11 Checking before Concrete

In addition to the checks in the according ITP, the following checks have to be carried out by the site engineer before casting concrete:

- Location and alignment of starter bars with the surveyor
- Concrete Cover on block outs and embeddings
- Cleanness of hidden areas (below block outs, horizontal waterstops etc.)

6 Health & Safety

- All persons have to follow the Contractor's Health and Safety Plan NH01 P 00 JV HMS 0001 latest revision.
- All persons working in the construction areas shall be required to wear PPE (Personnel protection equipment).
- Adequate lighting must be installed for night shift.
- All electrical installations must have ground fault circuit interrupter.
- All personnel shall attend the Contractor's Safety Training Sessions.

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7 Quality (Inspection, Testing and Documentation)

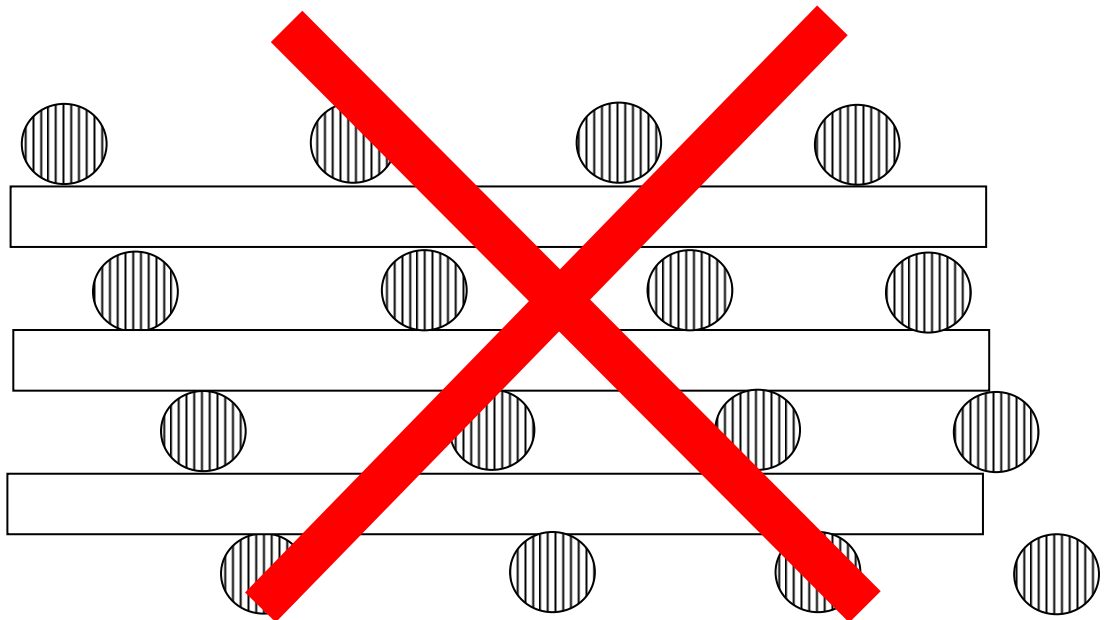
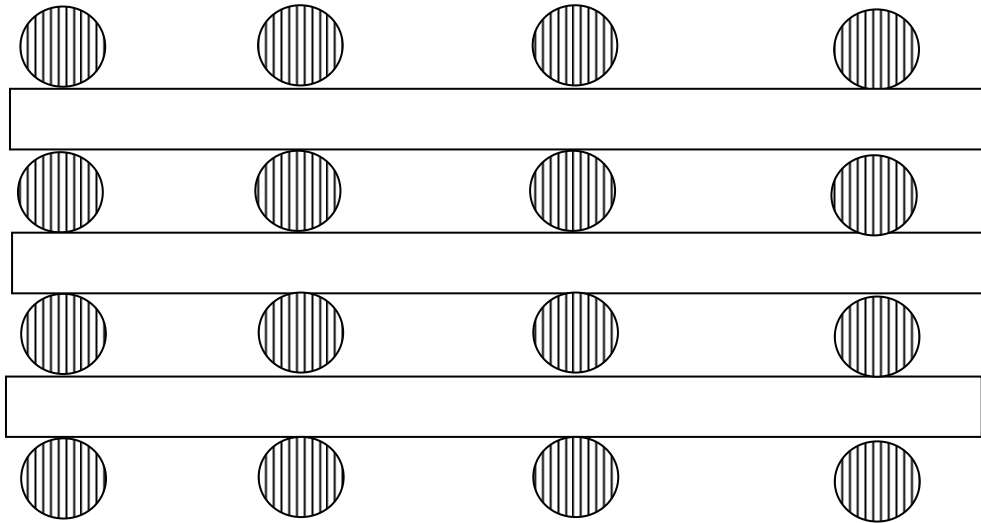
The full inspection and testing procedure for concreting is described in ITP NH01 P 00 JV ITP 0030.

After finishing the reinforcement fixing and formwork erection works, request for inspection has to be issued by the site engineer to the QC engineer and the final hold point check before concreting will be carried out.

Concrete shall be not placed until a concrete permit has been signed by the Employer.

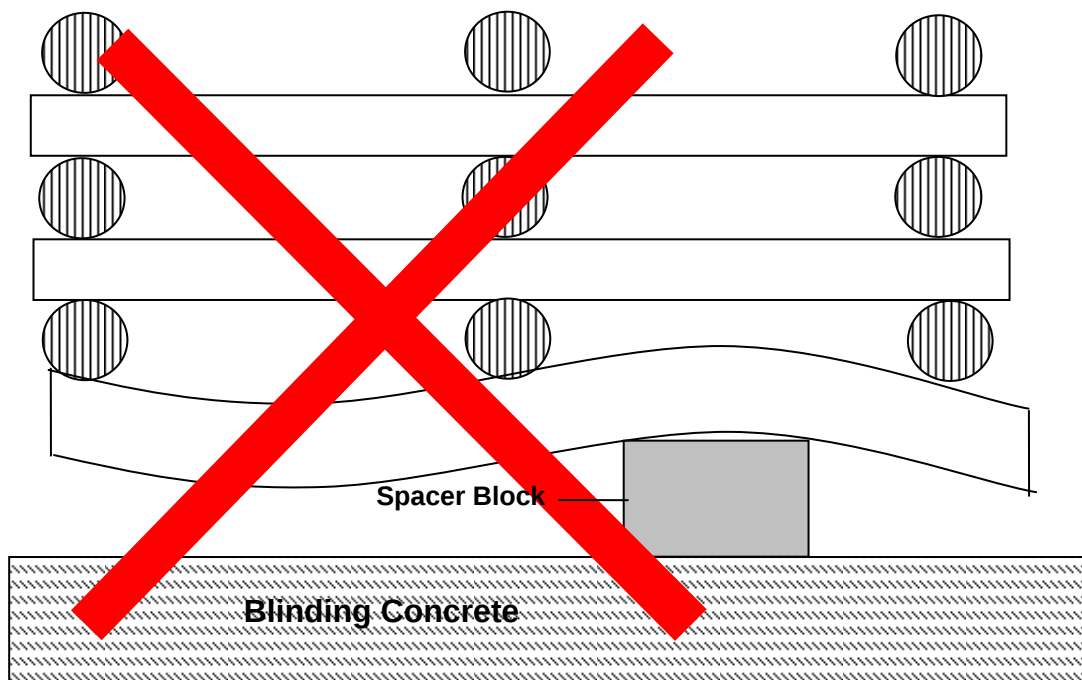
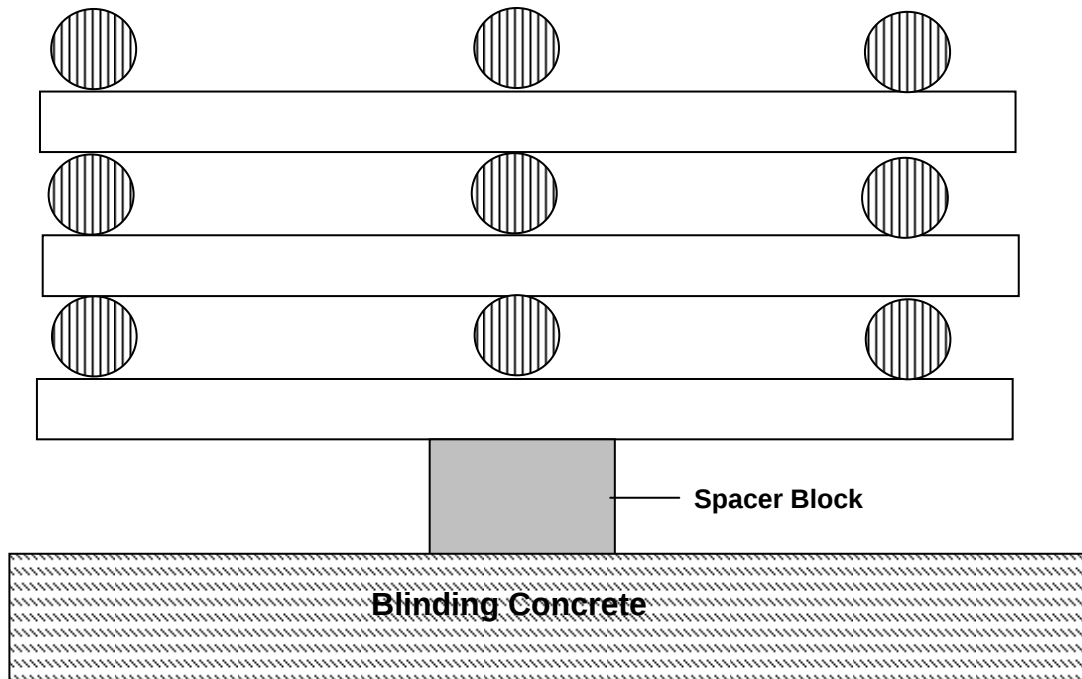
NHB – JV		Lot				Sc	Section		Issuer		Type			Number				Ind.
Reinforcement Placing and Fixing	Page No. 7 of 11	N	H	0	1	P	0	0	J	V	M	S	P	1	0	4	5	B

Placing and Vertical alignment of Rebar layers



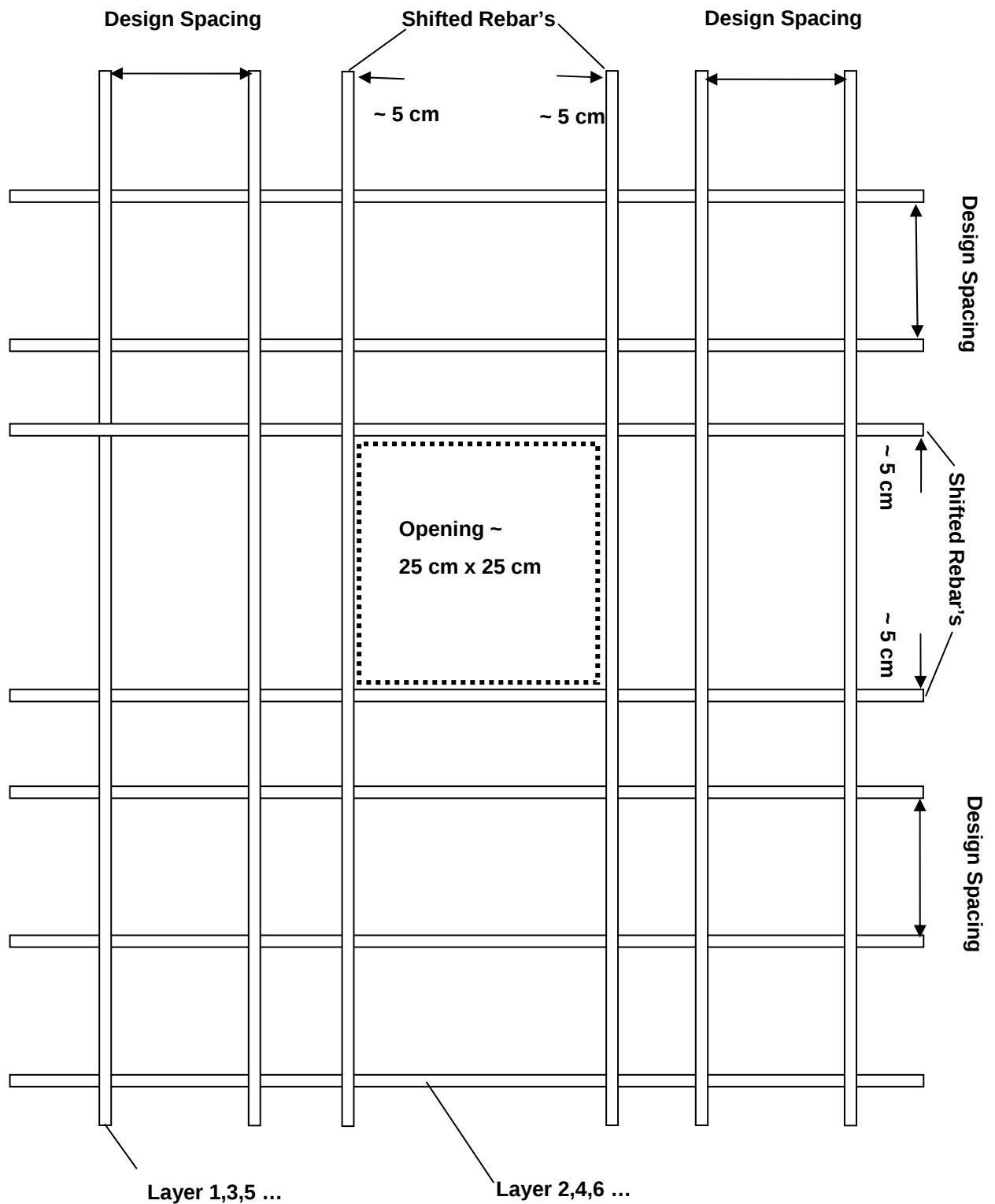
NHB – JV			Lot				Sc	Section		Issuer		Type			Number				Ind.
Reinforcement Placing and Fixing		Page No. 8 of 11	N	H	0	1	P	0	0	J	V	M	S	P	1	0	4	5	B

Placing and Location of Spacers



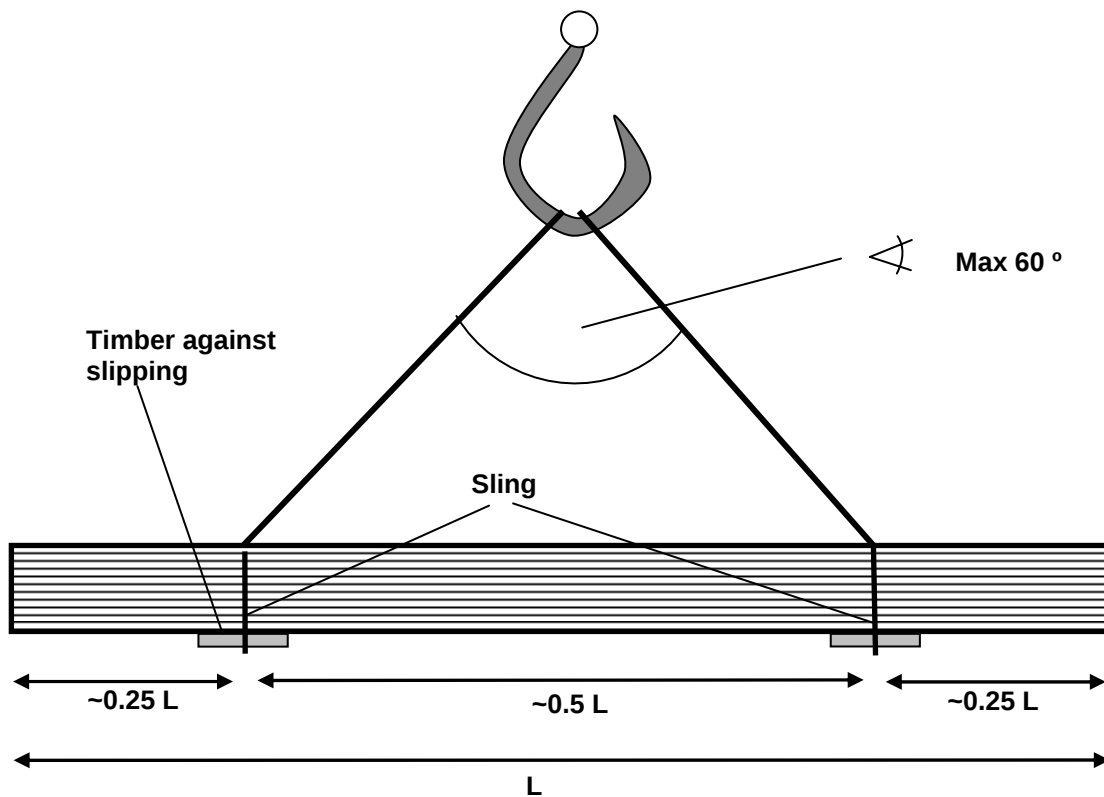
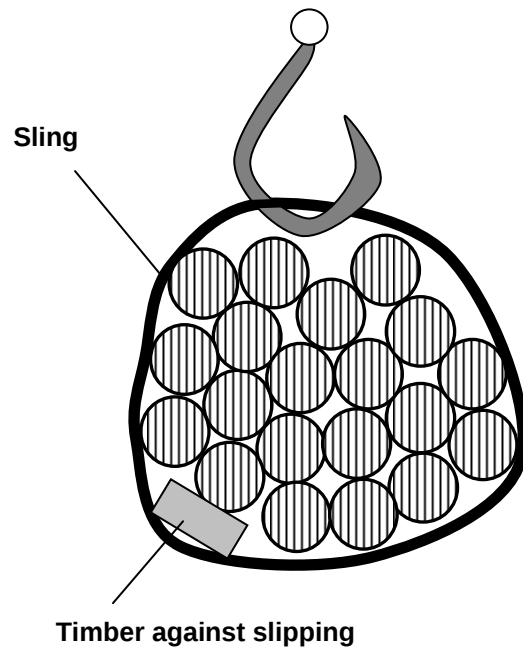
NHB – JV			Lot				Sc	Section		Issuer		Type			Number				Ind.
Reinforcement Placing and Fixing		Page No. 9 of 11	N	H	0	1	P	0	0	J	V	M	S	P	1	0	4	5	B

Opening for Concrete Placing



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Lifting of Reinforcement Bundles



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B	2005-01-10	K. Lindenbach	A. Gamal	F. Guinchard	Revised as per Consultant's Comments
A	2004-09-08	K. Lindenbach	A. Gamal	F. Guinchard	First issue
Ind.	Date	Prepared	Reviewed	Approved	Description

ARAB REPUBLIC OF EGYPT
MINISTRY OF WATER RESOURCES AND IRRIGATION (MWRI)
MINISTRY OF ELECTRICITY AND ENERGY (MEE)
HYDRO-POWER PLANTS EXECUTIVE AUTHORITY (HPPEA)

Naga Hammadi Barrage Development Consultants (NHBDC)

NEW NAGA HAMMADI BARRAGE AND HYDROPOWER PLANT

Lot 1 – Civil Works

Approval Stamp:

MWRI / NHBDC		
Document Review		
Document No:	Approval Sheet No:	
A	Approval	
AN	Approval except as Noted	
RR	Returned for correction and Resubmission	
	name	date
Checked:		
Approved:		
The approval of the documents will not exonerate the Contractor from any responsibility in connection with the works.		

Status Stamp:

Project Document No. : NH01 R 05 0100 B

Naga Hammadi Barrage Joint Venture (NHB-JV)

BILFINGER BERGER

VINCI
CONSTRUCTION
GRANDS PROJETS

ORASCOM
CONSTRUCTION - INFRASTRUCTURE

Method Statement

Temperature Measurements in Mass Concrete Pours

Originator: NHB JV	First issue date: 2004-09-08				Page No. 1 of 14											
	Reference				Identification Number											
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Appendix 1 - Equipment Specification

Appendix 2 - Measuring Points (installation of Measuring Wire)

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Method Statement Temperature Measurement in Mass Concrete Pours	Page No. 2 of 14	N	H	0	1	P	0	0	J	V	M	S	P	1	0	4	7	B

1 Scope

In situ temperature control to measure the development of heat hydration in selected pours of the mass concrete.

In the average the pours are 20 / 20 / 3 m about 1200 m³.

The temperature will be measured with data logger with connections to different places in the concrete pour.

The measuring will be applied for about two to three weeks.

2 Reference Documents

2.1 Contractual Documents

Particular Technical Specifications

Vol. 3, Part II, Section 5 "Concrete"

2.2 Other Documents

Concrete and Concrete Constituents Site Specification

3 Resources and Materials

3.1 Equipment

The following list is provisional and may be adapted to suit site requirements and needs:

Data Logger mikromec multi/s/e/n/s/, see appendix 1

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3.2 Personnel

The following list is provisional and may be adapted to suit site requirements and needs:

Laboratory Engineers

Laboratory Technicians

4 Execution

4.1 Measuring Points (installation of Measuring Wire)

The data logger has 8 canals for measuring of the temperatures and separately recording of each canal.

By the measuring of the temperatures the measuring wire will be fixed as follows.

Measuring wire no.: 1 and recording canal no.: 1	Ambient temperature
Measuring wire no.: 2 and recording canal no.: 2	Core temperature (Centre)
Measuring wire no.: 3 and recording canal no.: 3	Core temperature (Centre)
Measuring wire no.: 4 and recording canal no.: 4	left side centre about 5 cm inside from the outer concrete
Measuring wire no.: 5 and recording canal no.: 5	on the side of previous concrete at the centre about 5 cm inside from the outer concrete
Measuring wire no.: 6 and recording canal no.: 6	right side centre about 5 cm inside from the outer concrete
Measuring wire no.: 7 and recording canal no.: 7	centre down about 10 cm above the bottom
Measuring wire no.: 8 and recording canal no.: 8	centre on top about 5 – 10 cm under the top

All measuring wire will be fixed on a reinforced bar with clips.

For the placing of the measuring wire see appendix 2.

4.2 Recording of Temperatures

The data logger will be programmed that the reading and recording of the temperature perform every one hour on all points.

This data's can be printed on the printer (if the equipment is still working on site) or download by a PC.

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4.3 Frequency of in – situ Temperature Measurements

There is three data loggers available on site for measuring, the measuring of one pour will take about 2 to 3 weeks .

If the measuring of this pour is completed than will be decided which other pour will be measured as next.

The three data loggers will be always used that we have a overall view of the temperatures in the mass concrete pours.

5 Health and Safety Precautions

All persons working in the construction areas shall be required to wear personal protective equipment and use other safety equipment as required.

If necessary, adequate lighting must be installed for night shift.

All personnel shall attend the Training Sessions.

6 Environment Protection

All JV activities at site including those in the pit area obliged to abide by the provisions of the JV Environmental Management System and Environmental Protection Plan and its associated procedures.

Regular environmental inspections are undertaken by the Environment Department of the JV and the Environmental Inspectors of the JV. When bad practice or non-compliance is observed, an Environment Inspection Report (EIR) is issued.

All personnel shall attend the Contractor's Environment Awareness Training Sessions.

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Appendix 1 – Equipment Technical Specification

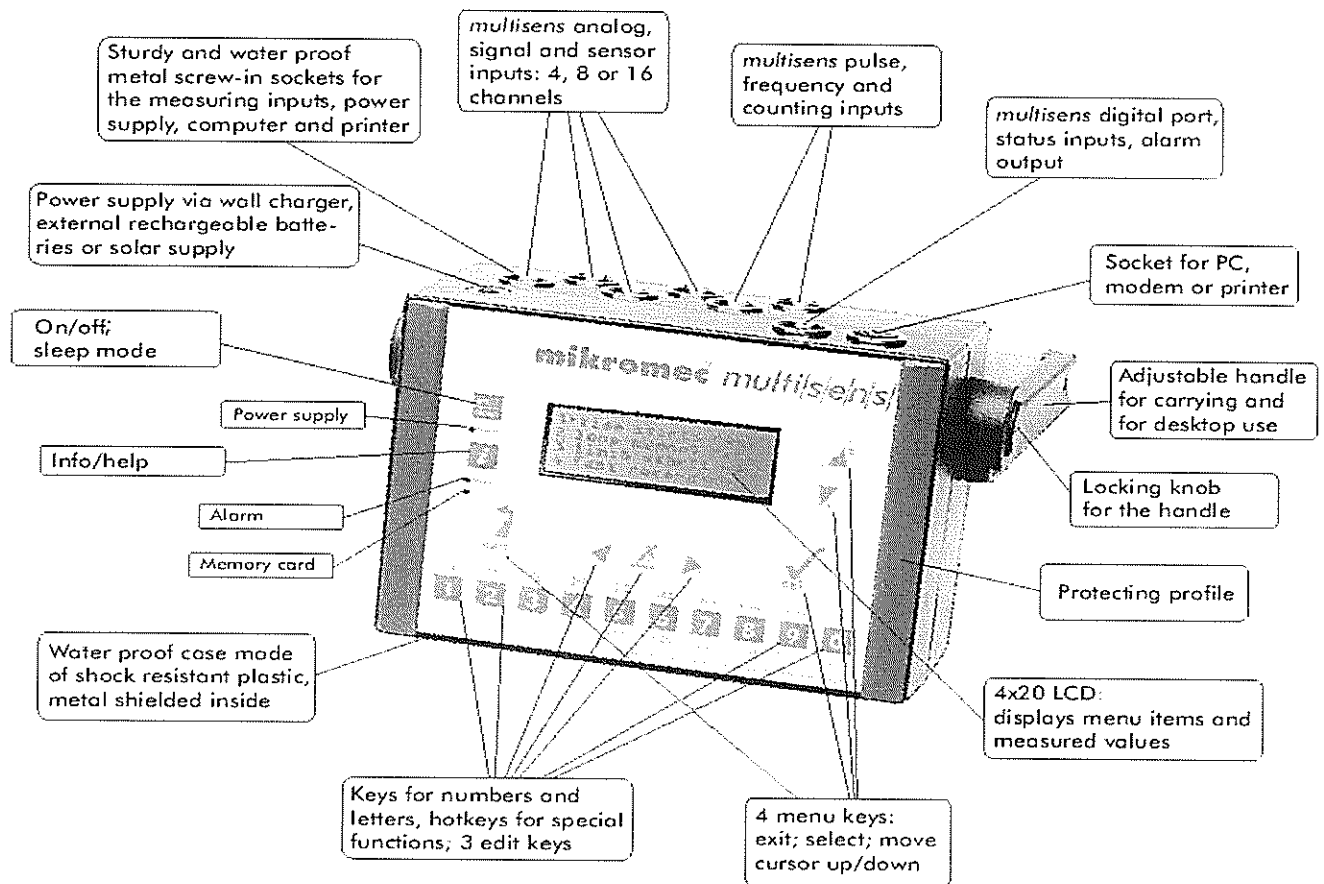
mikromec multisens data logger

NHB – JV		Lot				Sc	Section		Issuer		Type			Number				Ind
Method Statement Temperature Measurement in Mass Concrete Pours	Page No. 6 of 14	N	H	0	1	P	0	0	J	V	M	S	P	1	0	4	7	B

mikromec[®] multisens

mikromec[®] logger at your service

You do not need 20 questions
to find out how mikromec[®] logger works:



mikromec[®] multisens systems are so powerful because of their

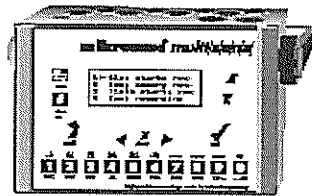
- display of measured values on the spot
- sophisticated and simple operating concept
- multisens measuring inputs for signals, sensors, pulses, counts, frequency and status
- high measurement precision and exceptional reliability
- sturdy and water proof construction for indoor and outdoor usage
- variety of models with 2 to 21 measuring channels
- large pool of accessories and sensors/probes as well as complete solutions

NHB - JV		Lot				Sc	Section		Issuer		Type			Number				Ind
Method Statement Temperature Measurement in Mass Concrete Pours	Page No. 7 of 14	N	H	0	1	P	0	0	J	V	M	S	P	1	0	4	7	B

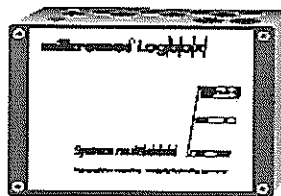
mikromec[®] multisens Systems - Technical Specifications

Models, General Functions, Measurement and Recording Functions, Inputs, Software

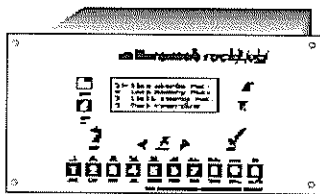
The mikromec[®] multisens system is based on TECHNINETICS' ten years of experience with modern and compact measuring and recording technology. The flexible and versatile system consists of dataloggers in 3 different designs each with 2 to 19 measuring channels, a comprehensive line of high quality sensors and accessories, and a configuration, data transfer and evaluation software for PC.



mikromec[®] logger MLM



mikromec[®] Logbox MLbm



mikromec[®] rackLog MrLm

mikromec[®] logger MLM

Full control without PC: the datalogger with display, keypad, and a turnaround, snap in grip.

- LCD-Display with 20x4 characters
- Foil covered mechanical keypad
- Menu-driven operation with multiple choice menus, setup menus, parameter windows and input masks
- 4 menu keys for simple and safe operation
- 10 character keys and 3 edit keys for a fast input of values, dimensions, comments etc.
- Hot keys for often used functions
- Info key for online help
- Display of measured values:
 - actual value and dimension of up to 8 sensors at a time
 - toggle between display of sensor name and actual value
- Display of measurements in real units by the function "scaling" simply enter sensor name, dimension, and reference points

mikromec[®] Logbox MLbm

- Operation, configuration and data transfer via PC.
- All other functions like mikromec[®] logger
- Optional available in water proof aluminium case

Common features of mikromec[®] logger and mikromec[®] Logbox

- Shock and water proof ABS case
- Wall fixture can be mounted later
- Fixture for panel installation available
- Dimensions (without grip):
 - 7 channel model: 184x138x83mm
 - 11 channel model: 184x138x135mm
 - 19 channel model: 184x138x172mm

mikromec[®] rackLog MrLm

- The compact unit for panel mounting
- Functions and operation compatible to mikromec[®] logger
- Dimensions of mikromec[®] rackLog: 3HE x 48TE x 175mm (129mm x 213mm x 175mm)

- Supply: 24V DC or AC, or 12-16V DC charging and operation
- Rechargeable battery and charging unit integrated
- Screw type connectors
- Alarm relay integrated; common alarm

Models of logger, Logbox, and rackLog

- The mikromec[®] multisens systems are offered with 2, 4, 8, or 16 multisens analog inputs (An or An-p inputs).
- Additionally, every model offers 2 multisens impulse/frequency inputs and 4 digital state inputs.
- Special models also offer electrically isolated analog inputs.

Models	Analog input An ^o or An-p	Pulse/ freq. input IF	Digital state input Dig	Total No. of channel
224	2	2	4	6
424	4	2	4	7
824	8	2	4	11
1624	16	2	4	19

Signal and Sensor Inputs

- More than 100 often used different sensors can be selected directly from the internal predefined list
- Integrated linearisation of sensor signals
- Measurement intervals:
 - every second for up to 8 analog inputs
 - every 2 seconds for 9-16 analog inputs
- The mikromec[®] multisens systems are equipped with unique multisens analog and sensor inputs with inputs for impulse and frequency and with digital state inputs

- multisens analog input: An^o or "An-p" voltage, differential mA, potentiometer, resistance, and bridge measurement RTD100, RTD1000, NI100, thermocouple 2- and 3-wire sensors
- An = ground related mA measurement
- An-p = mA measurement in loops
- multisens impulse/frequency input: IF for pulse signals and pulse sensors
- digital state inputs: Dig state binary recording and recording of state time, trigger and state on

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mikromec® multisens Systems - Technical Specifications

Models, General Functions, Measurement and Recording Functions, Inputs, Software

Recording

- Data storage:
 - standard for 128.000 readings
 - extensible up to 512.000 readings
- Measurement and storage of the readings in up to 9 logging records
 - different logging records parallel or in series
 - user defined memory allocation
- Recording of actual, mean, minimum, and maximum values
- Recording parameters of logging records
 - recording mode selectable
 - subset of preselected channels
 - recording interval: 1 sec. to 24 hours
 - duration: 1 minute to 1 year
 - start time: date, hour, minute
 - one channel 320 recordings per second
- Operation modes
 - continuous operation: measurement every second, storage at predefined intervals averaging of readings every second
 - sleep mode: intervals of 1 minute and longer for long-term battery-powered use; averaging of readings every minute
 - continuous wake-up for the duration of a logging record if recording interval is less than one minute
- Recording modes:
 - time recording: defined by start time and date, recording interval and duration
 - cyclic recording: the readings of a predefined duration are stored; parameters: recording interval, duration, storage time
 - limit recording: recording on limit violation, repetition until memory limit is reached; further parameters: recording interval, duration
 - recording with manual start and stop
 - start of a predefined logging record manually
 - single recording manually with or without annotation
 - high-speed recording up to 320/sec. in one channel; start manually or on limit violation
 - recording of a total of 40 readings per second in a user-defined number of channels

Data Transfer via PC-Card

- Data output of stored values on PC-Card (PCMCIA)
- Max. storage capacity up to 512.000 readings, like in the datalogger
- Read out data from PC-Card via PC-Card-Drive (supplied by TECHNETICS) to the PC

Interface and Communication

- Standard RS232 serial interface
- Safe data transfer rate up to 115 kBaud
- RS232 interface: electrically isolated
- Data transfer up to 30 meters at full speed, up to 100 meters at reduced BAUD-rate
- Special signal pins for safe remote access via modem
- Switch on of the datalogger by a call via a modem
- Command language for operation via PC

Plugs

- All plugs are versions equipped with screw locking, rugged and waterproof. All contacts with plating of gold
- Cable connectors and female plugs use standardized products

Alarm Outputs

- On each channel 2 alarm limits free selectable value + direction
- Standard configuration: one common alarm output at the digital port, TTL limit
- Optional: common alarm output with built-in relay with switch-over-contacts
- Optional: up to 2 alarm outputs at each channel by connecting an external relay-module at the digital port DIG

Power Supply

- Built-in, lead acid rechargeable battery, no maintenance required, battery capacity: 12V 2Ah
- Charging while operation with separate mains charging unit or DC-charging unit. Optional external power supply: 12V-battery or 12V to 16V DC supply possible
- mikromec® rackLog: mains unit integrated
- Solar modules and panels as accessories
- Real time clock and data RAM buffered separately by Li-battery
- Run times:
 - 24 hours continuous use 118 hours
 - 25.000 times wake-up in sleep mode (20.000)
- Values in brackets for parameter: when alarm mode is activated: 1 test read data (approx. 70%)

High Stability

- Consequent EMC design for high immunity to conducted and radiated noise
- Extensive tests: vibration, shock, temperature, humidity, corrosion, salt spray, etc.
- High stability and accuracy even under severe conditions
- The factory check certificate provides information on the inspection of each output

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mikromec[®] multisens Systems - Technical Specifications

Models, General Functions, Measurement and Recording Functions, Inputs, Software

Analog Signal Inputs and Processing	- A/D resolution: 15bits, i.e. $\pm 16,000$ values - Continuously integrating conversion features high noise immunity and great 50/60Hz line rejection	- Repeatability: 10,000 discrete values - Accuracy: $\pm 5,000$ divisions, i.e. 12bits over operating temperature (-20 to +60°C) - Long term drift: max. 0.02% per year
Precision Reference Voltage, Low Drift	- Internal precision reference for self calibration every second - Reference voltage 5.000V ± 3mV - Temperature drift typical ± 3ppm/°C (± 20ppm max.)	- Drift per year ± 180ppm, i.e. $\leq 0.02\%$ - Reference voltage pin for bridge or potentiometrical measurement on all multisens analog An plugs - Delivers up to 40mA, protected against short circuit
Constant Current Source	Constant current for RTD100-, RTD1000- and resistance measurement at all multisens analog inputs of type 'An'	Excitation current is appr. 1mA (effective ≤ 0.3mA, since it is time-multiplexed at all active channels)
Voltage Measurement	- Measuring ranges: 25mV, 50mV, 100mV, 200mV, 1.25V, 2.5V, 5V, 10V - Signal range: $\pm 120\%$ of nominal scale, overrange detection and display on violation of this range - True differential measurement in common mode range of -11V to +11V (typical) - Higher voltages by special cables	- Ground related measurement is performed by adding a wire in the sensor plug - Supply- and signal-grounds are placed at two different pins - Input resistance > 10MΩ, overload protected up to 100V DC, 60V AC continuously
Resistance Measurement	- Constant excitation current, 4-wire technology features precision, independent of sensor cable length - Measuring ranges: 200Ω, 1KΩ, 5KΩ, 8KΩ	Potentiometrical resistance measurement up to 250kΩ
Bridge Measurement	- Bridge type sensors directly connectable - Strain gauges, force, torque	Bridge excitation 5.000V, 40mA max. load
Current (20mA) Measurement	- Current measurement 20mA in loops with p-models without external module - Ground related measurement, with n-models, measurement in loops with measuring module in connecting cable	- Measuring resistance appr. 24Ω, i.e. only appr. 0.5V drop 2- and 3-wire-transmitter directly connectable
Sensor Supply	11V to 14V depending on charging level, 14V if mains unit connected, max. load 400mA - other voltages supplied by external DC-converters	Electronic fuse cuts off above 600mA and can be reset by pressing on/sleep-key twice
Sensors with Built-in Electronics	- Transducers and transmitters for temperature, pressure - Sensors for climate parameters: humidity, air velocity with vane or thermal sensor - Consumption parameters: water/gas flow, utility networks parameters	- Sensors for meteorology: different radiation types, wind speed and direction, wind vector - Hydrological quantities: water level, water quality - Chemical quantities: pH, conductance - Mechanical quantities: displacement, inclination, angle, force, weight, torque, pressure

NHB - JV		Lot				Sc	Section		Issuer		Type			Number				Id
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mikromec[®] multisens Systems - Technical Specifications

Models, General Functions, Measurement and Recording Functions, Inputs, Software

RTD100 and RTD1000 Measurement

- No error caused by cable length, since 4-wire-technology measurement
- Repeatability of RTD100-measurement
-30 to +70°C: 0.02°C
-200 to 550°C: 0.1°C
- Differences between different input channels $\pm 0.02^\circ\text{C}$ max
- Temperature drift of RTD100-measurement typ $\pm 0.02^\circ\text{C}$ per 10°C change in logger temperature

Type	Measuring range	Resolution	default accuracy
RTD100	-30 to +70°C	0.01°C	$\pm 0.05^\circ\text{C}$
RTD100	-200 to +550°C	0.1°C	$\pm 0.1^\circ\text{C}$
RTD1000	-200 to 400°C	0.1°C	$\pm 0.1^\circ\text{C}$

Thermocouples K, J, L, T, U, S, B

- Cold junction temperature compensation is mounted on an equithermal block at the input connectors
- Accuracy of the cold junction compensation in a thermal stable environment $\pm 0.2^\circ\text{C}$

Type	Measuring range	Resolution	Accuracy
K	-200 ... 600°C	0.1°C	0.2°C
	-200 ... 1300°C	1°C	1°C
J	-200 ... 450°C	0.1°C	0.2°C
	-200 ... 1200°C	1°C	1°C
L	-200 ... 450°C	0.1°C	0.3°C
T	-200 ... 400°C	0.1°C	0.3°C
U	-200 ... 450°C	0.1°C	0.3°C
S	0 ... 1700°C	1°C	1°C
B	200 ... 1800°C	1°C	1°C

Impulse and Frequency Measurement

- Standard configuration: 2 multisens IF impulse/frequency inputs
IF accepts TTL, Namur Reed, Opto, AC-Sensors, incl. Sensor supply
optional: 4 impulse/frequency IF-inputs

- Continuous counting function during sleep mode is activated by a wire inside the sensor cable connector
- Frequency display range is 0 to 9999 Hz
- Impulse measurement display range 0 to 9999 impulses in each registration interval

Digital State

- Standard configuration: 4 status inputs at digital port, TTL-level; the datalogger supplies most pulse sensors

- Register together with analog signals, level or slope-sensitive recordings
- Status inputs, external expandable up to 20

Further Quantities

- Electrically isolated measurement, mA input of An input isolated
- Separately isolated inputs: 2V, 10V, 20mA, optional internally or with external modules
- AC-signal modules: true RMS, 100mV, 1V, 1A

- External modules for signal conditioning of signals out of mains supply networks
- Signal conditioning modules to access signals and sensors in an EX-environment

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Method Statement Temperature Measurement in Mass Concrete Pours	Page No. 11 of 14	N	H	0	1	P	0	0	J	V	M	S	P	1	0	4	7	B

mikromec[®] multisens Systems - MM-grafix

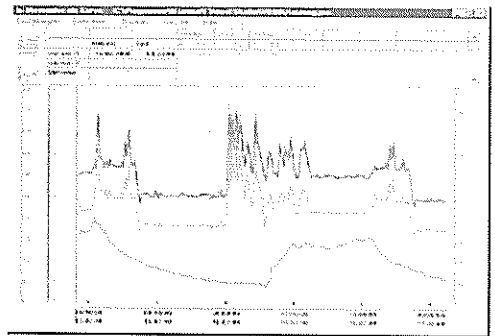
Data Transfer and Evaluation Software

Data Transfer from Datalogger to PC

- Via RS232 serial interface
- 300 - 115,200 BAUD, selectable
- memory card (PC-Card / PCMCIA)
- automatically, via modem
- data transfer directly in Excel

Stored Values as Graphs

- View up to 30 graphs on one grid or as up to 20 separate grids on one screen
- Show/hide single graphs
- Zooming and scrolling in user defined intervals
- Graphs in different colours or with symbols
- Graphs as polygons with interpolating splines
- Measuring data displayed as bar charts
- x/y representation of two channels
- Cursor for reading of numerical data from graphs on the screen
- Up to 4 different Y axes in one screen
- Automatic or manual scaling of the axes
- Automatic matching of the axes of two channels with similar ranges



- Up to 500,000 values per graph

Stored Values in Tabular Format

- Headline and table of data in format recording time channel1 channel2
- Additional comment input field
- Editor for stored values

Preparing of Logging Records

- Save parts of a logging record as new logging records
- Delete parts of a logging record
- Divide one logging record in several ones
- Compress logging records to reduce data
- Unite different logging records in one

Processing of Logging Records

- Calculation of new channels
- Conversion of channels using predefined equations (e.g. $C3 = 0.5 * (C1 + C2) - 1.28$)
- Calculation of dew point, F0 value etc
- Variables in equations (e.g. channel [temperature])
- Frequency distribution of stored values
- Frequency above/beneath a cursor position
- Mean, maximum, minimum, standard deviation, totals
- Smooth a curve
- Linearisation

Online Mode

- Online data transfer from datalogger to PC
- Online display of measured data
- Online display of graphs
- Online display in virtual instruments
- Online saving to floppy disk/hard disk
- Interval selectable from 1 second to 1 hour

Documentation

- Print stored values in list format
- Print hard copy of graphs
- HPGL-output
- Graphical output in PCX file
- Graphics export to Windows applications
- User defined input fields for additional text

Data Storage

- In ASCII format
- In user defined format
- Export in MS-Excel
- In selectable different formats for word processing and calculating programmes

Setup

- VGA graphics
- COM1, COM2, COM3, COM4
- Dialogue languages: English, German, French, Dutch, Danish

Modules

- Purpose built software modules available for special monitoring needs
- Store values in a database
- Configure the datalogger
- Calculate pressure in gas pipes
- Collect values via modem automatically, periodically
- Further modules upon request

PC Configuration

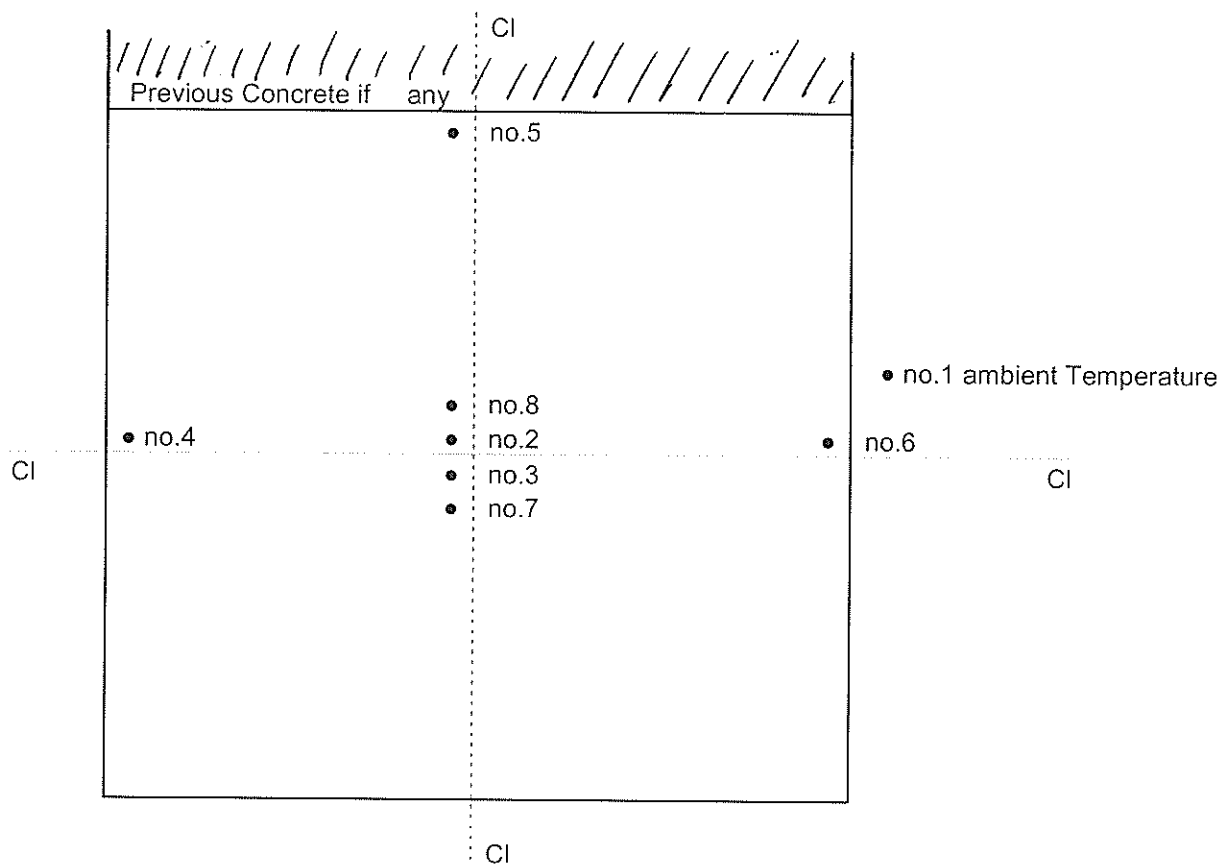
- DataB memory
- Software driver
- RS232C serial port
- Keyboard, mouse, floppy disk, printer

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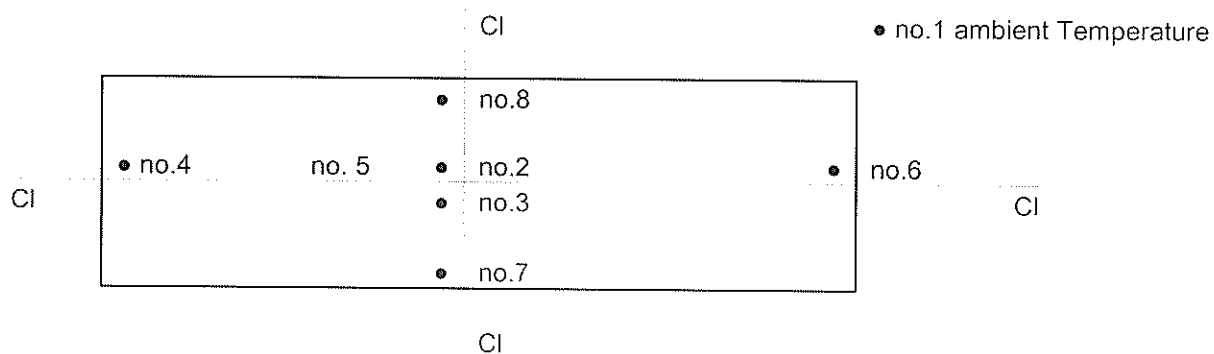
Appendix 2 – Measuring Points

Installation of measuring wire

The size of the Concrete Block is mostly 20m / 20 m / 3.0 m



Plan view



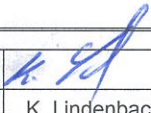
Section

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Measuring Points

Measuring Wire no.:	1	Ambient Temperature
Measuring Wire no.:	2	Core Temperature (Centre)
Measuring Wire no.:	3	Core Temperature (Centre)
Measuring Wire no.:	4	left side fixed Centre about 5cm from outer Concrete on the Reinforcement Bar
Measuring Wire no.:	5	on the Side of previous concrete fixed Centre about 5cm from outer Concrete on the Reinforcement Bar
Measuring Wire no.:	6	right side fixed Centre about 5 cm from outer concrete on the Reinforcement Bar
Measuring Wire no.:	7	Centre down fixed about 10 cm above the bottom fixed on the Reinforcement Bar
Measuring Wire no.:	8	Centre on the top about 5 to 10 cm under the Top fixed on the Reinforcement Bar

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E	2006-01-03	K. Lindenbach	E. Hardgrave	E. Hardgrave	Revised as per Consultant's Comments
D	2005-08-08	K. Lindenbach	E. Hardgrave	F. Guinchard	Revised as per Consultant's Comments
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A	2004-09-20	K. Lindenbach	U. Benkert	F. Guinchard	First issue
Ind.	Date	Prepared	Reviewed	Approved	Description

ARAB REPUBLIC OF EGYPT
MINISTRY OF WATER RESOURCES AND IRRIGATION (MWRI)
MINISTRY OF ELECTRICITY AND ENERGY (MEE)
HYDRO-POWER PLANTS EXECUTIVE AUTHORITY (HPPEA)

Naga Hammadi Barrage Development Consultants (NHBDC)

NEW NAGA HAMMADI BARRAGE AND HYDROPOWER PLANT

Lot 1 – Civil Works

Approval Stamp:

MWRI / NHBDC		
Document Review		
Document No:	Approval Sheet No:	
A	Approval	
AN	Approval except as Noted	
RR	Returned for correction and Resubmission	
	name	date
Checked:		
Approved:		
The approval of the documents will not exonerate the Contractor from any responsibility in connection with the works.		

Status Stamp:

Project Document No. : NH01 05 R103 / E

Naga Hammadi Barrage Joint Venture (NHB-JV)

 **BILFINGER BERGER**

 **VINCI**
CONSTRUCTION
GRANDS PROJETS

 **ORASCOM**
CONSTRUCTION INDUSTRIES

Method Statement Concrete Production and Delivery to Site

Originator: NHB JV	First issue date: 2004-09-20								Page No. 1 of 62								
	Reference								Identification Number								
	Lot				Sc	Section		Issuer		Type			Number				Ind.
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1 Scope

The concrete which will be used for the New Naga Hammadi Barrage will be mixed on site by fully dedicated mixing plants erected and operated by OCI. There are three Concrete Mixing plants installed at the same Location. The transportation between the plants and the pouring site will be performed by OCI owned Concrete Mixer Trucks.

2 Reference Documents

2.1 Contractual Documents

- Particular Technical Specifications
- Vol. 3, Part II, Section 5 "Concrete"

2.2 Other Documents

- Concrete and Concrete Constituents Site Specification
NH01 P00 JV SPE 1028 E
- Quality Assurance Plan
NH01 P00 JV QMS 0001 A
- Health and Safety Plan
NH01 P00 JV HMS 0001 E
- Environment Protection Plan
NH01 P00 JV EMS 0001 E
- **Method Statements**
- Production of Fine Aggregate for Concrete
NH01 P00 OC MSP 1039 C
- Production of Coarse Aggregate for Concrete
NH01 P00 OC MSP 1042 C
- Cement Transportation and Storage
NH01 P00 OC MSP 1041 C
- Fly Ash Transportation, Handling and Storage
NH01 P00 OC MSP 1040 C
- Admixtures Transportation, Handling and Storage
NH01 P00 OC MSP 1043 B

3 Quality Control and Assurance Plans for the Concrete Production and Delivery to Site

3.1 Purpose

Client's Quality requirements are understood and met.

Quality System is planned, documented, understood, implemented through out the operating staff.

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3.2 Objectives

The objective is for the Contractor to safely and successfully bring the Project completion. To do so, the following priorities must be set.

- To ensure first and foremost that the work is carried out safely.
- To provide a well-defined organization with a clear definition of responsibilities.
- To compile a comprehensive written Procedural System to ensure all work instructions are clear, job descriptions and responsibilities are well defined, and that all activities and actions carried out are auditable against these procedures.
- To ensure that the correct documents and drawings are distributed to all involved.
- To ensure that contract specifications are met.
- To ensure that procedures pre-empt mistakes and misunderstandings as to documents, materials or construction.
- To ensure that the most economical, safe and sure construction methods are used.
- To have a System to control non-conformances, should they occur, and implement correction action.
- To implement a Quality Assurance System to assist in meeting these objectives.

3.3 Following ITP's have to be used

Concrete Production	NH01 P00 JV ITP 0011 B
Cement and Cementitious Blend	NH01 P00 JV ITP 0026 B
Fly Ash	NH01 P00 JV ITP 0027 B
Aggregates	NH01 P00 JV ITP 0028 B
Admixtures	NH01 P00 JV ITP 0029 B

4 Organization

This section specifies the organisation structure for the Quality Control Plan and outlines the responsibilities assigned to the operating staff concerning the production of the concrete as follows.

- Ensuring the quality of work carried out by personnel within their respective departments or discipline.
- Verifying that approved procedures are adopted within their department or discipline.

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- Ensuring that all staff within their authority are adequately qualified and/or experienced in their relevant discipline to perform the duties of their position in satisfactory manner.
- Ensuring that staff are familiar with the Project Procedures and have ready access to them.
- Ensuring that staff are fully aware of their individual responsibilities for the activities with which they are involved.
- The Inspection Team as detailed in the organization structure shall consist of nominated member of the Project Team, selected on the basis of experience / relevant training for the particular activity involved.
- See attached Appendix IX Concrete Production Organization Chart.

5 Quality Management System

5.1 Introduction

The Quality Management System detailed hereafter provides the basis a systematic and uniform approach to the effective and economical management of quality. The principle is to ensure that the quality requirements are determined and satisfied through all phases of the project.

It is structured to provide:

- The definition of the manner in which activities contributing to the quality of work to be carried out.
- Objective evidence showing that such activities are satisfactorily carried out in the manner defined and that activities conform with specified requirements.

The Joint Venture is committed to the operation of the Quality System described and its supporting procedures, and to ensuring that the system is:

- Made effective at all levels within the organization.
- Promoted with interest and enthusiasm.
- Duly monitored at appropriate intervals to verify effectiveness and efficiency.
- Updated and amended to reflect current quality Practices.
- Administered and implemented by staff with appropriate experience and training in order to ensure the required standard and maintained.

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5.2 Process Control

See part 8 Checks

5.3 Non Conformance

Documented procedures shall be established implement and maintained to ensure that:

- Materials found to be non-conformance to requirements shall be identified and segregated to prevent unauthorized acceptance, and issue contamination of conforming.
- All non conformances are fully documented and recorded.

6 Resources and Materials

6.1 Equipment

6.1.1 Two Concrete Mixing Plants model: C.S Johnson 430

- Brand: USA
- Size : max. 3 m³ / Batch
- Capacity : 90 m³ / hour (actual output is 60 / 65 m³ / hour each Plant)
- Control System: Computerized control system
- Aggregate: Fine and coarse aggregates is filled to separate hopper's

From where each size of aggregates are separate transported by a belt conveyor to a storage silo with a capacity of 4 times 10 m³, this is fixed on top of the mixing plant. 2 of this boxes is for sand and the other 2 is for coarse aggregates under this silo is the aggregate scale fixed with a additional weighing system.

- System adding Admixtures: Computerized system to add liquid admixture
- Water: Adjustment of sand water content is an automatic controlling system contact with water sensor device imbedded in sand.
- Cement and Fly ash: Cement and fly ash will be charged by a screw conveyor from ground level of the silos to the cement fly ash scale.
- Calibration: Monthly checks according to PTS 5.4.2.11
- General Equipment: The mixing plants provided with Ampere meter, batch printer and delivery note.

6.1.2 One Concrete Mixing Plant model: Elba EBC – D 105

- Brand: Germany
- Size: max. 2.0 m³/Batch
- Capacity: 80 m³/hour (actual output 60 m³/hour)

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- Control System: Computerized control system
- Aggregate: Fine and coarse aggregates is filled to separate hoppers.
The weighing system is under the hoppers (weighing belt) after finishing with the weighing of all aggregates the belt will be emptied in to the skip of the mixing plant. This Skip bring the aggregates up to the mixer.
- System adding Admixtures: Computerized system to add liquid admixtures.
- Water: Adjustment of concrete mixing water content in the sand, the moisture content will be checked in the laboratory and the result will be put in to the plant computer.
- Cement and Fly ash: Cement and fly ash will be charged by screw conveyor from ground level of the silos to the cement / fly ash scale.
- Calibration: Monthly checks according to PTS 5.4.2.11
- General Equipment: The mixing plant is provided with consistence meter, batch printer and separate delivery note.

6.1.3 Water Chilling Plant

- 3 pcs. Container of water chilling plant, each mixing plant one chilling plant.
- Type: CCWP.3 154-40k-50HZ.
- Capacity: Each plant can produce 6.4 m³ / hr. cold water 5°C for the mixing plant and flake ice production.

6.1.4 Flake Ice Production

- 2 pcs. Container for flake ice production.
- Type: FLIP 42.
- Production: Each ice plant can produce 1.75 tons / hr.

6.1.5 Flake Ice Storage

- 2 pcs. Container type c/s23.
- Storage capacity each container 23 tons.
- Total storage capacity is 46 tons.

6.1.6 Electric Power Plants

- 3 Elec. Generator 350 KVA for the batch plants. (VOLVO type)
- 2 Elec. Generator 320 KVA for the batch plants. (VOLVO type)
- 4 Elec. Generator 300 KVA for the washing plants. (VOLVO type)

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- 4 Elec. Generator 500 KVA for the chilling and ice plants. (VOLVO type)
- 4 Elec. Generator 250 KVA stand by. (VOLVO type)

6.1.7 Equipment for loading of the Hoppers ect.

- 5 pcs. Wheal loader. .
- Brand: Caterpillar, John Deer.
- Capacity 2.5 m³.

6.1.8 Transportation of the Concrete

- 15 pcs. of Truck mixer lorries.
- Brand of Trucks: Sterling (USA).
- Brand of Mixer: REX WORKS (USA).
- Capacity: 8 m³ each truck mixer lorry.

6.2 Personnel

- 2 Plant Manager (Engineer).
- 2 Quality Control Engineer.
- 2 Service Engineer in charge of the plants.
- 4 Plant Operator per plant and 1 replacement.
- 5 Wheal loader Operator per shift.
- 2 Mechanics per shift.
- 4 Helpers per shift.
- 25 Truck mixer lorry drivers per shift.
- 1 First aid person.

6.3 Storage of fine and coarse aggregates

- All fine material (Sand) will be supplied from approved sources direct to the sand washing plants near the Site. Ready washed and mixed material to the required proportions, will be supplied to the boxes at the storage areas at the mixing plant.
- All coarse material (Gravel 4/16 mm and 16/32 mm) will be supplied from

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approved sources to the gravel washing plants at the mixing plant area, After washing, this material will be stored in separate boxes near the mixing plants.

All boxes are covered with a light roof to prevent direct sun shine on the material (high temperature).

6.4 Storage of cement

- Five silos are installed with a capacity of 140 tons each on every mixing plant.
- Two silos for plant three with a capacity of 140 tons each
- The feeding pipe of each silo is marked with the type of cement which is stored in the silo.
- Every silo is provided with one safety valve (pressure control).
- Every silo is equipped with a dust filter.

6.5 Storage of fly ash

- One silo are installed with a capacity of 140 tons each on every mixing plant.
- One silo for plant three with a capacity of 140 tons.
- The feeding pipe of each silo is marked with the type of fly ash which is stored in the silo.
- Every silo is provided with one safety valve (pressure control).
- Every silo is provided with a dust filter.

6.6 Admixture

- For the concrete will be only one type of admixture used.
- The admixtures will be stored in 2 tanks with a capacity of 2,000 ltrs. each batching plant.
- Two 40,000 ltrs. tanks is erected on site, one each batching plant under admixture supplier instructions.
- One 10,000 ltrs. Tank is erected on site for the third plant under admixture supplier instructions.
- All tanks will have a automatically pump for circulating the admixture.

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6.7 Water storage

- 2 water tanks (normal water temperature) with a capacity of 15,000 ltrs. each tank is installed beside of each mixing plant.
- 2 water tanks (chilled water storage) with a capacity of 50,000 ltrs. each tank is isolated and installed by the chilling plants.
- 1 water tank (chilled water storage) with a capacity of 30,000 ltrs. for plant three, tank is isolated and installed by the chilling plants.

7 Operation

7.1 Ordering of concrete

- Each section manager sends at the end of each week a fortnightly consumption program, to the concrete department, allowing for stock provision.
- Moreover, a daily concrete consumption schedule is sent to the mixing plant manager, at the end of the day for the next working day.
- The site engineer issues the request for concrete, one day before pouring.
- A priority list is then established in coordination with the construction manager which determines the effective concrete delivery schedule to be implemented during the next working day.

7.2 Mixing of concrete on the mixing plant

- The mix design data and loading sequence are entered in the computer program by the plant operator and amended when required.
- The data and the plant parameters are periodically checked by the site laboratory for compliance with the latest revision of approved concrete mixes "calculated quantities for the mixing of concrete" and with plant parameters defended by the plant manufacturer.
- These datum and the plant parameters shall be protected with a password available with the laboratory manager.
- The list of approved concrete mix formulas will be available in the plants

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control room.

- Prior to introduction of concrete, the drum of the truck mixer shall be rotated on the emptying mode, making sure no water is remaining.
- The plant operator issues the delivery note, based on the request for concrete. The plant operator shall input the data of loading in the delivery note with the start time of loading of the concrete in the truck mixer.

The sequence of mixing at plant one and two is as follows:

- Aggregates weighing by sensor (load cell) on the hopper.
- Cement and fly ash weighing by load cells installed on the scale.
- Measuring the supplied water amount by flow meter.
- Measuring of flake ice by separate scale.
- Measuring the admixture in dispensers (volume).
- Start and unload the aggregates with the flake ice to the mixing plant mixer.
- After 10% aggregates allow (water + admixture) to the mixer.
- After 10 % from (water + admixture) unload the cement and fly ash.
- Mix for 90 sec. and then unload in the truck .
- Each truck mixer will be loaded with maximum quantity (7.5 m³) of concrete.
- If the concrete have to be cooled, the total water will be divided in to chilled water and flake ice.
- The chilled water (5 °C) will be stored in the insulated water tank and will be pumped directly to the flow meter.
- The flake ice will be supplied by a screw conveyor from the ice container to the ice scale and from there the ice will be discharged directly on to the aggregates of the aggregate conveyor.
- The function mode of the plant is automatic.
- In case of failure, the manual mode is adopted after advising the mixing plant engineer.
- The plant operator shall record this case on the delivery note filled in at the plant.
- In this case, manual mode is used until the end of the engaged

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concreting cycle, which cannot be interrupted.

- Automatic mode resumes when repair is made.

The sequence of mixing at the third mixing plant is as follows:

- Aggregates weighing on the weighing belt (load cells) under the hopper.
- Cement and fly ash weighing on the scale (load cell).
- Measuring the supplied water amount by scale (load cell).
- Measuring the admixture by scale (load cell).
- The function mode of the plant is automatic.
- Start automatic loading, the weighed aggregates on the weighing belt is unloaded in to the skip which bring the combined aggregates up and in to the rotating mixer.
- The cement fly ash quantity will be unloaded from the scale in to the mixer.
- The water will be added and on the end also the admixture.
- Then the mixing will be for 60 seconds.
- After unload in to the truck mixer max. quantity 8 m³ of concrete.
- By automatic cycle one batch is mixing a second in the skip is in waiting position and a third is weighing on the weighing belt.
- If the concrete has to be cooled, there will be block ice given in to the chilled water in the storage tank, to cool the water below 5 °C.
- In case of failure of the automatic mode, the manual mode is adopted after advising the mixing plant engineer.
- The plant operator shall record this case on the delivery note filled in at the plant.
- In case manual mode is used until the end of the engaged concrete cycle, which can not be interrupted.
- Automatic mode resumes when repair is made.

7.3 Transportation of the concrete from plant to the site

- According to the priority list, concrete is loaded in truck mixers which have been insulated in case of ambient temperature exceeding 32°C.
- On arrival at the site of delivery, the person in charge of site and the arrival, pouring, the laboratory technician registers signs the delivery note and the arrival and departure times of the truck mixer on the pouring report.

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- Furthermore, and where relevant, flow, temperature are registered on the concrete pouring report by laboratory technician.
- If the concrete is rejected, the QC engineer shall explain on the delivery note the reason of this rejected concrete, he also shall instruct the truck mixer driver to hand back the delivery note to the mixing plant operator for further instruction.
- This rejected concrete has to be washed out of the truck (no adjustment on the same load will be accepted).
- The filled – in and signed original of the delivery note remains with the site engineer.
- It is the responsibility of the concerned QC engineer to review and sign the concrete pouring report.
- If the truck mixer is leaving the site empties its water tank in rotating mixer drum in order to clean it.
- On arrival at the batching plant, the waste is emptied in the sump pit tank at the dump area.
- The total time from leaving the site up to finished washing of the mixer drum is registered for maintenance purposes.

7.4 Maintenance of the equipment

It is performed continuously in the following manners for the mixing plant:

- On a systematic basis, by the mechanic and the plant operator under direct supervision of the mixing plant engineer. It consists mainly in routine maintenance (greasing, checking of oil levels, cleaning discharge gates, mixer, etc.).
- On the basis of a periodical maintenance schedule determined in coordination with the mechanical department and applied by mechanics and electricians of the mechanical department.
- On occasional basis, in case of system failure reported by the plants operator.

Mixer trucks and Loader

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- The company performed the periodic inspection carried from the schedule of preventive maintenance.
- The inspection recorded in the equipment check – list form that supervised the check – up.
- The check – list form should submit from office of the operation & maintenance manager for his approval and consent.
- In other cases, like emergency on the site or outside the plant.
- The workshop supervisor orders the mechanics to send on the area where requested equipment located.
- After the work is done successfully the mechanics that made the repair for equipment on emergency should reported to the maintenance supervisor.
- And this would be the basis of information to be written in the job - order forms, it also included the job - order forms into the maintenance break down.

7.5 Spare parts storage

- The company builds spare part storage to maintain the efficiency of maintenance in each equipment for a limited time. Each spare part purchased in Cairo are kept in the separate room in workshop storage. The spare parts are labelled with the same parts code based on the receipt of the supplier. The storing of spare parts are under the supervision of the storekeeper, where he arranged the storage of the spare parts as for the classification of equipment. After the spare parts received, the storekeeper check for the quality and quantity of spare parts.

If the spare parts are inferior in quality the storekeeper automatically inform the workshop supervisor to make the decision what to do.

The storekeeper checks the report and records the out of stock and direct issue of requisition order to purchase for another stock.

7.6 Communication between the Batching plant and placing Points.

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There are mobile phones with every shift manager, operation and QC Engineer. By mobile phone can be always contact reached between concrete placing points (site engineer) and concrete mixing plant.

8 Checks

8.1 Internal checks on the mixing plant

The plant operator and / or the mixing plant engineer are responsible for three main types of internal checks as follows:

- Checks before loading of the mix.
- Checks during loading of the mix.
- Checks of the measuring and weighing devices.

8.1.1 Check before loading of the mixes:

- Water content of the fine and coarse aggregates checks are performed under the site laboratory's responsibility, prior to start the daily concrete production.
- This checks are reported during the concrete production upon request from the plant operator or the laboratory representative.
- Drum of the truck mixer checked by the plant operator if it is empty before loading of the truck.

8.1.2 Checks during loading of the mixes:

This checks are performed in the control room of the plant:

- For each mix, the plant operator is responsible for executing the following operations:
- Checking of the correct operation of the weighing , supplying and loading sequence through the computerized synoptic chart existing in the plant control room.
- Checking of the correct amount of each component on the weighing control board.
- Checking that each weighing unit resumes its zero value after emptying of the hopper.

8.1.3 Check of measuring and weighing devices:

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- These checks executed under the mixing plant engineer's responsibility.

8.2 External checks

- The quality representative, who performs random inspections at the plants and / or the pouring place in order to ensure that the present procedure is correctly applied, perform the checks.
- Check of computer's data: These checks, executed by the site laboratory are the checking for design data, sequences and plant parameters weekly.
- Calibration of all measuring and weighing devices by the Employer, Consultant, JV Laboratory and plant Staff monthly.

8.3 Field control test

- Field control tests are performed by site laboratory, these tests include:
- Aggregate gradation's.
- Aggregate moisture content.
- Flow.
- Concrete temperature.
- Density of fresh concrete.
- Air content.
- Concrete specimens (cubes 20/20/20 cm)

9 Incidents

9.1 Anomalies during the mixing process

- If a failure is detected, the plant operator interrupts the automatic cycle and proceeds on manual mode.
- If weighing devices do not resume their position after emptying of the hopper, the plant operator shall, empties the hopper from its remaining content.

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- No further batches shall be started until the failure is safely and completely repaired.

9.2 In case of insufficient flow after mixing

- If the truck has been waited for too long time more than the permissible according to the trial mix results the concrete will be rejected for disposal (see 12.8).

10 Hot weather concreting

During periods of hot weather, especially if accompanied by dry air, Necessary precaution to prevent adverse effects on the fresh concrete or on hardened concrete will be taken as the follows:

- Shaded storage of fine and coarse aggregates.
- Sprinkling of coarse aggregates.
- Above tanks for mixing water will be provided with shade and thermal Insulation.
- Painting silos and mixers surface white covering mixer trucks with cloth which will be wetted during loading to minimize solar heat gain.
- Using high water reducing and plasticizing admixture.
- Using chilled water.
- Adding flake ice in the mixer.
- Using of low heat of hydration cement (CEM I 42,5 N LA LH or CEM III B 32,5 N LA) for mass concrete and (CEM I 42,5 R LA) for structural concrete.
- Schedule truck mixer to minimize waiting time.
- Consider night time concrete placement directed by JV.

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11 Health and safety

A safetyman will be permanently affected to the guidance of the traffic of trucks And will check the safety of subcontractor's equipments.

The site clinic is near to the mixing plants.

Clear signalling will be installed for the axis roads, processing and stockpile.

Adequate lighting for the night shift works will be provided at mixing plant's.

A fence is erected around processing area.

Fire fighting equipment will be placed near fuel tanks.

The labours will be provided with safety equipment (safety helmet, safety Shoes, safety glasses).

12 Environmental

12.1 Environmental protection plan

- The JV Environmental Protection Plan and associated Plans and Procedures will be complied with.

12.2 Maintenance of vehicles

- Maintenance of vehicles (see 4.4) to take place at the workshop area and any used oils will be stored and disposed of as per JV procedures.

12.3 Exhaust emissions

- The mixing plant's will be inspected to ensure efficient operation conditions are maintained and no excessive exhaust emissions are produced.

12.4 Noise

- The operators will be given appropriate personal protection, particularly earmuffs.

12.5 Waste water

- waste water from the process is collected in waste water tanks. The PH of this waste water will be monitored and the water mixed with the waste water from the gravel washing process and unload this waste water at the flood channel area.

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12.6 Oil / Fuel storage

- Any oil / fuel storage shall be on an impervious base with raised edges and no drainage outlet.

12.7 Excessive dust

- A mobile water tank will spray water onto access roads and inside the processing area regularly to control dust generated.

12.8 Rejected concrete

- Washing out of rejected or any unused concrete to take place in designated waste holding area mixed with sand and transported for final disposal in the Flood Channel Disposal Area.

12.9 Environmental training

- All personnel shall attend regularly the contractor's Environmental awareness training sessions.

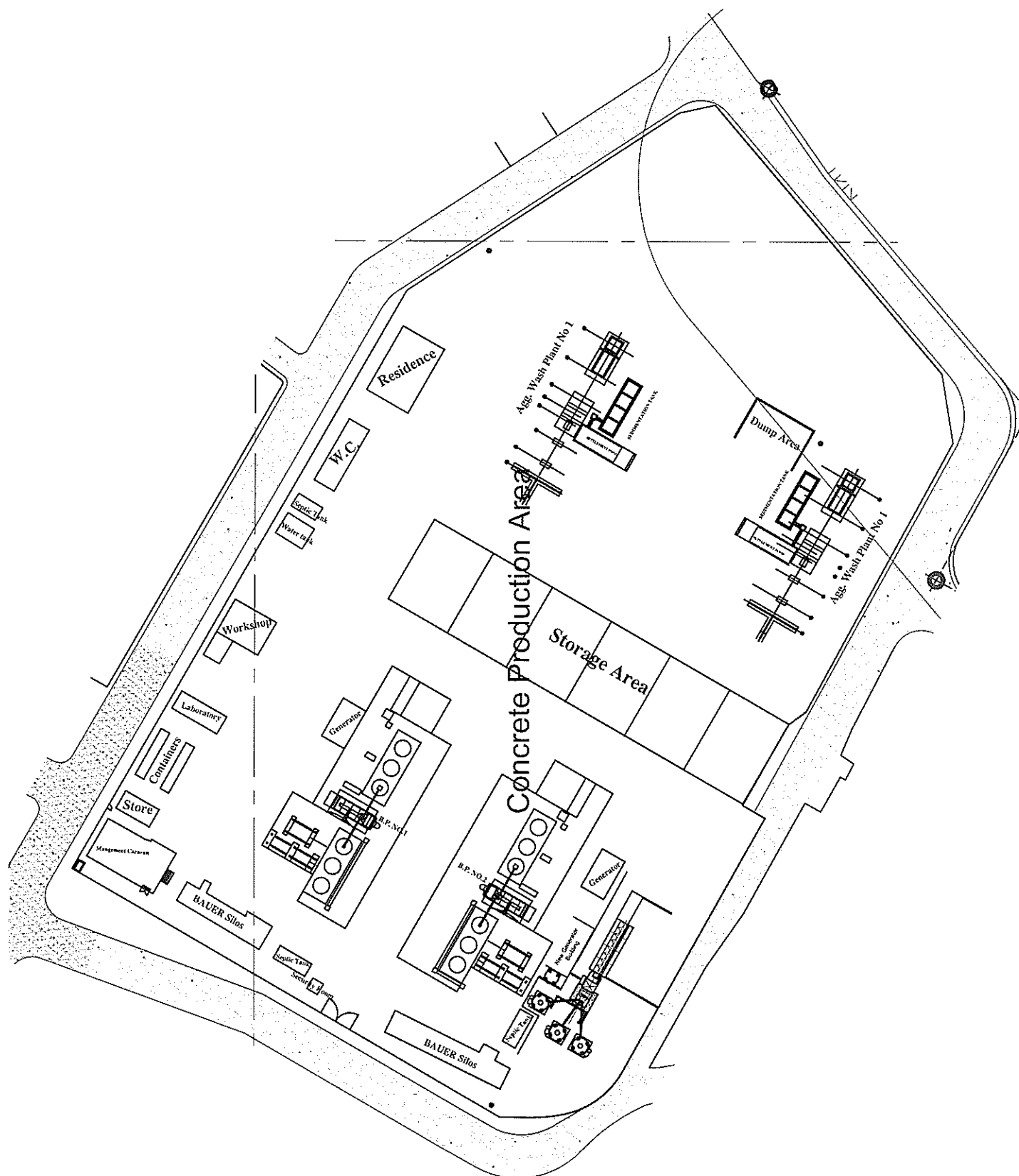
NHB – JV		Lot				Sc	Section		Issuer		Type			Number				Ind.
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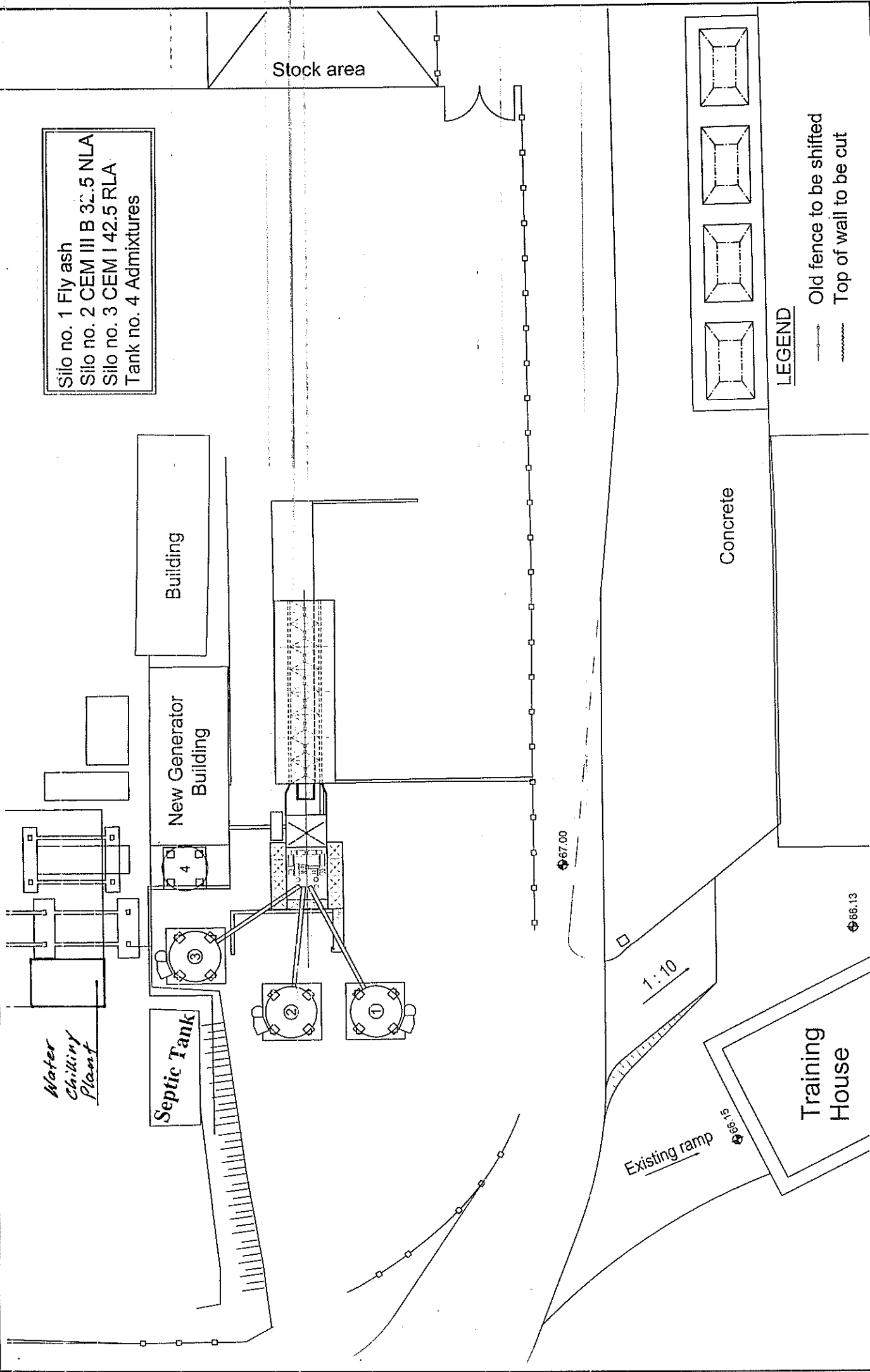
Appendix I

Layout Concrete Mixing Plants

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The Batching Plant Layout





Silo no. 1 Fly ash
 Silo no. 2 CEM III B 32.5 NLA
 Silo no. 3 CEM I 42.5 RLA
 Tank no. 4 Admixtures

LEGEND

- Old fence to be shifted
- Top of wall to be cut

Reference				Identification Number					
Lot		Sc	Section	Issuer	Type	Number			
N	H	0	1	T	1	4	J	V	D
1	2	3	4	5	6	7	8	9	10
Page No. 2 of 2				Ind.					
Scale : 1:250				Format : A3					

SITE INSTALLATION
 LAYOUT OF BATCHING PLANT No. 3

Appendix II

Technical Documents of the two Concrete Mixing Plants Johnson – Ross 430 Raider

See Version B from 2004-12-13

NHB – JV		Lot				Sc	Section		Issuer		Type			Number				Ind.
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Appendix III

Technical Documents of the third Concrete Mixing Plant

See Version D from 2005-08-08

NHB – JV		Lot				Sc	Section		Issuer		Type			Number				Ind.
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Appendix IV

Chilled Water and Flake Ice Plants, incl. Layout of the Chilled Water And Flake Ice Production Containers

See Version B from 2004-12-13

NHB – JV		Lot				Sc	Section		Issuer		Type			Number				Ind.
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Appendix V

Concrete Truck Mixer

See Version B from 2004-12-13

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Appendix VI

Material approval flow Diagram

See Version B from 2004-12-13

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Appendix VII

Equipment Maintenance Checklists

See Version B from 2004-12-13

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Appendix VIII

Checklist for Calibration of all Scales at the Concrete Mixing Plant

See Version B from 2004-12-13

NHB – JV		Lot				Sc	Section		Issuer		Type			Number				Ind.
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Appendix IX

Concrete Production Organization Chart

See Version D from 2005-08-08

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A	2004-10-16	Aiman Wally	A. Rahaman	F. Guinchard	First issue for approval
Ind.	Date	Prepared	Reviewed	Approved	Description
ARAB REPUBLIC OF EGYPT MINISTRY OF WATER RESOURCES AND IRRIGATION (MWRI) MINISTRY OF ELECTRICITY AND ENERGY (MEE) HYDRO-POWER PLANTS EXECUTIVE AUTHORITY (HPPEA)					
Naga Hammadi Barrage Development Consultants (NHBDC)					
NEW NAGA HAMMADI BARRAGE AND HYDROPOWER PLANT					
Lot 1 – Civil Works					

Approval Stamp:			Status stamp:		
MWRI / NHBDC					
Document Review					
Document No:		Approval Sheet No:			
A	Approval				
AN	Approval except as Noted				
RR	Returned for correction and Resubmission				
	name	date			
Checked:					
Approved:					
The approval of the documents will not exonerate the Contractor from any responsibility in connection with the works.					

Project Document No. : NH01 05 R114 / A

Naga Hammadi Barrage Joint Venture (NHB-JV)		
		

Method Statement The Concrete Production Related Traffic On/Off Site	
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Originator: OCI	First issue date: 2004-10-16						Page N° 1 of 14									
	Reference						Identification Number									
	Lot	Sc	Section	Issuer	Type	Number	Ind									
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The Concrete Batching Plant Traffic through Production

Scope:

This document aims on demonstrating the outlines for the traffic related to the concrete production i.e.(On/Off Site Traffic), beginning with the raw material gathering, processing, transporting to the concrete batching plant and ending by delivering concrete to site.

Off Site Traffic (Transportations of Materials to Site):

• Fine Aggregate

The estimated number of trips for the sand transportation from the borrow pits to the sand washing and processing plant was found to be 40 to 50 trip/day.

This number of trips will be cut through a number of hauling trucks varying from 15 to 20 trucks; of capacities between 10m³ to 15m³.

For more details concerning the accesses roads for sand transportation, please refer to the attached map I, annex A.

• Coarse Aggregate

The estimated number of trips for the gravel transportation from the borrow pits to the concrete batching plant was found to be 30 to 40 trip/day.

This number of trips will be cut through a number of hauling trucks varying from 8 to 10 trucks; of capacities between 10m³ to 12m³ and/or 4 to 6 big trailers of capacities between 25m³ to 30m³.

For more details concerning the accesses roads for gravel transportation, please refer to the attached map II, annex A.

• Cement

The estimated number of trips for the cement transportation from the cement factory to the concrete batching plant was found to be 15 to 20 trip/day.

This number of trips will be cut through a number of bulk trailers varying from 20 to 30 bulks; of capacities between 30 tons to 40 tons.

For more details concerning the accesses roads for cement transportation, please refer to the attached map III, annex A.

• Fly Ash

The estimated number of trips for the fly ash transportation from Safaga harbor to the fly ash storage area (El Qawasa) was found to be 15 to 20 trip/day.

This number of trips will be cut through a number of bulk trailers varying from 10 to 12 bulks; of capacities between 30 tons to 40 tons.

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OCI				Lot				Sc	Section		Issuer		Type			Number				Ind.				
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A number of one to two loaders will be used for feeding the gravel washing plants with the raw gravel; they will be used also for transporting the washed gravel coming out of the washing plants to its proposed storage area under sheds.

For further details, refer to the attached batching plant layout, annex B.

• Fly Ash

The estimated number of trips transporting the fly ash from the storage area at (Qawasa) to the batching plant was found to be 4 to 5 trip/day. These trips will be cut using a number of 2 bulk trailers of 30 tons capacity the each.

• The Mixing Zone Area

As depicted through the attached batching plant layout, annex B, it is clear that a fine-tuning system was placed in order to avoid crowded traffic either between truck mixers or hauling trucks.

A number of two loaders is used for feeding the both mixing plants with fine and coarse aggregates from under sheds.

A water truck is always spraying the accessed roads inside and outside the batching plant for controlling dust.

All the refilling processes for cement and fly ash silos will take place after the complete day production in order

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Annex A

(Mapping)

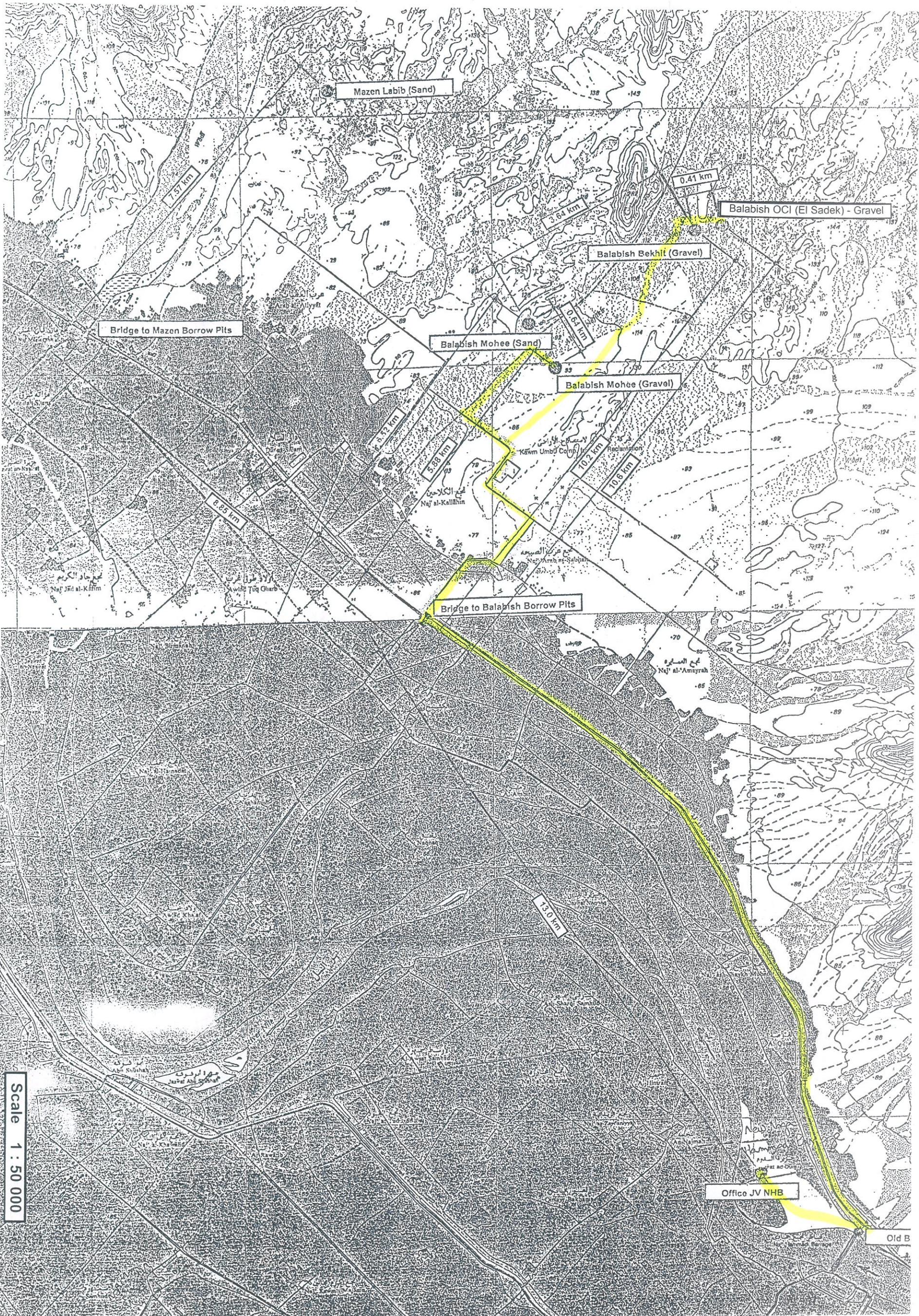
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Map I: Transportation of Sand from the Borrow Pits to the Sand Washing Area

Scale 1 : 50 000

2-



Map II: Transportation of Gravel from the Borrow Pits to the Gravel Washing Area

Scale 1 : 50 000



Base 500650 2-72

**Map III: The Roadway Map for Cement Transportation
From ECC To Site**

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Map V: The Roadway for The Admixtures Transportation From The 6th October City To Site

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OCI				Lot				Sc	Section		Issuer		Type			Number				Ind.		
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SAND WASHING PLANT AND STOCK PILE AREA

- ① Hauling trucks bringing unwashed sand from
- ② Trucks unloading raw sand at the proposed area
- ③ Loader used for loading the plant with raw sand
- ④ Loader used for loading trucks with the processed washed sand
- ⑤ Hauling trucks loading the processed washed sand
- ⑥ Hauling trucks transporting the processed washed sand to the batching plant

Fish Spawning Area

MIXED WASHED SAND

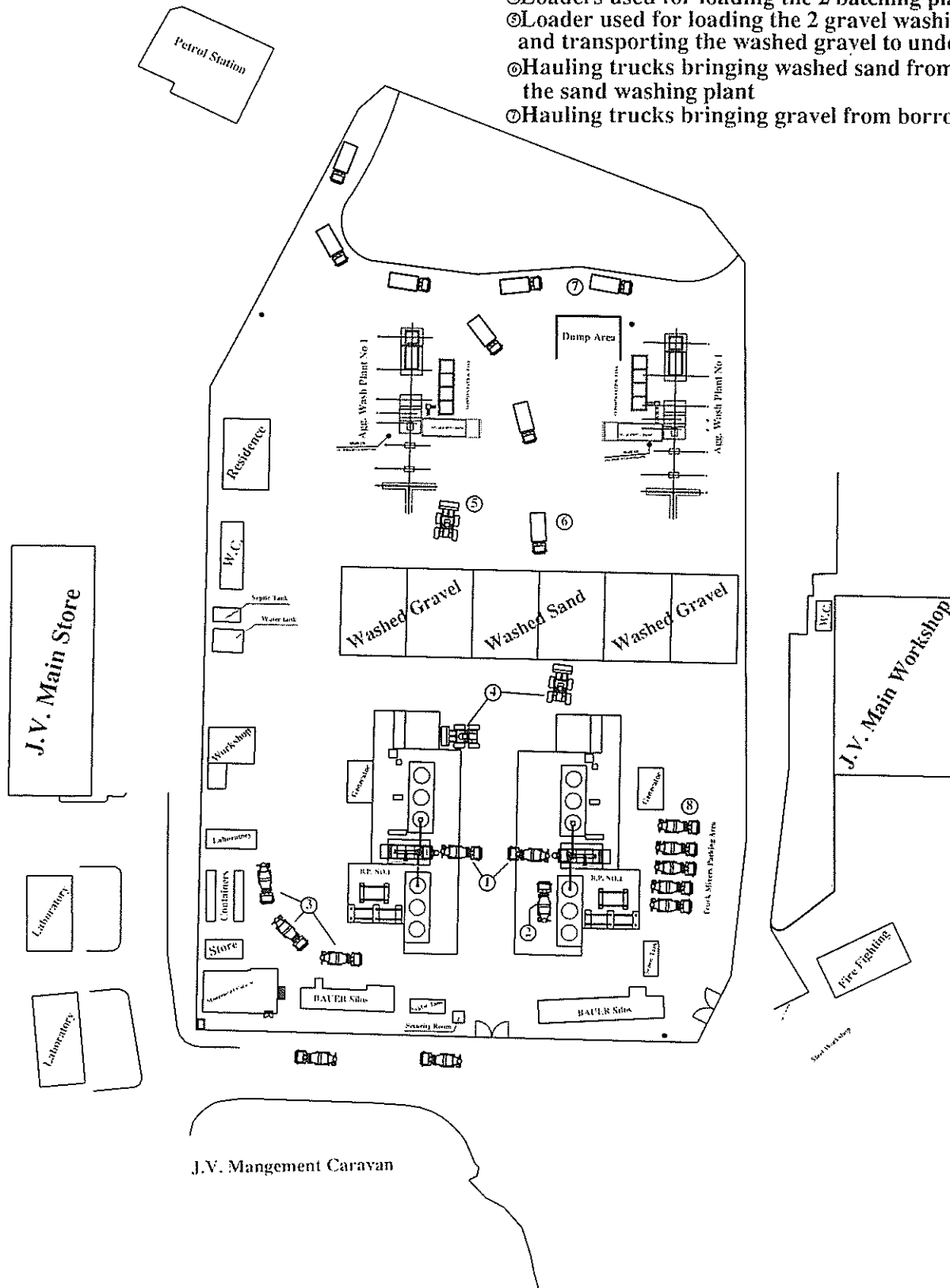
The Coarse Aggregate Stock Piling Area

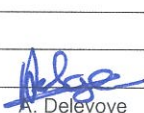
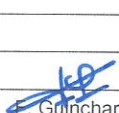
New Road

New Road

The Batching Plant Layout

- ① Trucks loading concrete
- ② The next loading truck
- ③ Trucks waiting thier turn to take position 2
- ④ Loaders used for loading the 2 batching plants
- ⑤ Loader used for loading the 2 gravel washing plants and transporting the washed gravel to under sheds
- ⑥ Hauling trucks bringing washed sand from the sand washing plant
- ⑦ Hauling trucks bringing gravel from borrow pits



					
B	2004-12-13	A. Delevoye	J. Pereira	F. Guinchard	Revised as per NHBDC comments
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ARAB REPUBLIC OF EGYPT
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 MINISTRY OF ELECTRICITY AND ENERGY (MEE)
 HYDRO-POWER PLANTS EXECUTIVE AUTHORITY (HPPEA)

Naga Hammadi Barrage Development Consultants (NHBDC)

NEW NAGA HAMMADI BARRAGE AND HYDROPOWER PLANT

Lot 1 – Civil Works

Approval Stamp:

MWRI / NHBDC		
Document Review		
Document No:	Approval Sheet No:	
A	Approval	
AN	Approval except as Noted	
RR	Returned for correction and Resubmission	
	name	date
Checked:		
Approved:		
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Status stamp:

Project Document No. : NH01 05 R139 / B

Naga Hammadi Barrage Joint Venture (NHB-JV)

 **BILFINGER BERGER**

 **VINCI**
CONSTRUCTION
GRANDS PROJETS

 **ORASCOM**
CONSTRUCTION INDUSTRIES

Method Statement Cutting and Bending of Reinforcement

Originator: NHB JV	First Issue :2004-12-04										Page No. 1 of 5					
	Reference										Identification Number					
	Lot				Sc	Section		Issuer		Type			Number			Ind
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3	RESOURCES.....	3
4	MATERIALS.....	3
5	EXECUTION INSTRUCTIONS.....	4
6	HEALTH AND SAFETY	5

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1 Introduction

The choice has been made by the Contractor to prepare on one centralised site yard the cut and bent reinforcement bars necessary to the construction of the navigation locks, sluiceway, powerhouse and other miscellaneous works.

This document aims to detail the cutting and bending operations.

2 Reference Documents

- Particular technical specifications: Vol.3 Part II Section 5.7 (steel reinforcement).
- Method Statement for Reinforcement Fixing and Placing.

3 Resources

3.1 Plant and Equipment

The lifting and hauling equipment consists of:

- one gantry crane with a capacity of 12tons equipped with a magnetic spreader beams for the handling of bundles of 12 to 18m long bars,
- one tower crane type Liebherr 180/ECH covering the cutting and bending machines and the storage area for cut and bent bars,
- one head tractor and 4 to 6 tail trailers for the delivery of cut and bent bars to the placing sites.

The cutting and bending equipment consists of:

- three "Offmeh" cutting machines C52, C42 and C36,
- three "Offmeh" bending machines P52, P42 and P36.

The capacities of the machines are 40mm, 32mm and 25mm for the "52", "42" and "36" types respectively.

3.2 Personnel

The following standard team set-up will be assigned for each shift for the cutting and bending:

- 1 General Foreman,
- 3 Foremen respectively in charge of steel handling & site delivery, cutting and bending.
- 3 Cutting Operators
- 3 Bending Operators
- 15 to 20 Helpers

4 Materials

Reinforcement steel in 12 to 18m lengths as specified by the PTS.

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5 Execution Instructions

5.1 Reception and Storage of Long Bars

When delivered to site from the factory and before unloading, long bars will be inspected as follows:

- Control of the delivery note,
- Consistency of the delivery note with the delivered materials including:
 - bars length and diameter,
 - number of bundles,
 - grade of steel and milling marks.

These checks are detailed by Inspection and Test Plan NH01 P 00 JV MSP 0033.

After these checks, trucks are unloaded in the correct racks depending on the diameter and the length of the bars. Some quantities which do not need cutting and bending will be directly delivered and stored into the construction pit at the related storage area. Care will be taken not to place bundles on support towers which are not designed to support such loads.

5.2 Preparation of Cutting

The construction drawings and bar bending schedules issued by NHBDC are analysed and detailed by NHB JV drawing analysts. Site bar bending schedules and tags are prepared two weeks in advance to the site needs.

The general foreman in charge of cutting and bending sorts the tags per diameter and per length and prepare the daily program of cutting taking into account the capacities of the machines.

5.3 Cutting

The foreman in charge of cutting takes the tags and distribute them to each operator and loads the cutting racks with the diameters and lengths which the operator needs.

The operator adjusts the stoppers on the cutting racks for the lengths, and with the assistance of 2 or 3 helpers, he proceeds to the cut and control of the bars. The first bar cut must be checked with the length given on the tag.

When the total quantity has been done, the operator checks if the total number of bars is in accordance with the tag. After this control, the tag is attached to one bar of the bundle in such a way that it is clearly visible. The bars are wired together with 4mm steel wires for further handling.

The cutting foreman takes out the bundle and send it to:

- the bending foreman if necessary if bending is required,
- the stock foreman to stock in the correct area before delivery to the pit for bars which are not to be bent.

5.4 Bending

The foreman in charge of bending receives the bundles from the cutting area and checks the length, diameter and numbers of bars in the bundle to ensure that they are consistent with the tag.

The operator choose the chuck for the bar diameter, takes the dimensions and adjust the stoppers for the different lengths. Then he adjusts the angles of bending and bends the first bar.

The operator controls the lengths and angles on the first bar. When it is correct, he continue with all bars of the bundle. When all bars have been done, the bars are attached together with 4mm ropes and the tag is attached in such a way that it is clearly visible.

NHB – JV		Lot				Sc	Section		Issuer		Type			Number				Ind.
Cutting & Bending of Reinforcement	Page No. 4 of 5	N	H	0	1	P	0	0	J	V	M	S	P	1	0	6	0	B

The bending foreman takes out the bundle and transfer it to the foreman in charge of stock to put it in the correct area before delivery to the pit.

5.5 Storage

The storage area is divided in four zones:

- Navigation Lock – Zone 1,
- Sluice Way – Zone 2,
- Powerhouse – Zone 3,
- Miscellaneous works – Zone 4.

The foreman in charge of storage and site delivery receives the bundles. The zone number (1 to 4) is written on the tag. He places the bundle in the right area, ready for the site delivery.

The foreman writes on the bar list each received bundle and when the bar list is finished, the bar list is given back to the supervisor to incorporate it into the delivery planning.

5.6 Delivery

A weekly delivery planning is prepared. Each delivery is to be confirmed 24 hours in advance.

The general foreman gives the bar lists to the foreman in charge of delivery. The latter loads the trailers and checks if all the bars of the bar lists are on the trailers.

The foreman then gives the bar list to the driver who delivers the trailer to the correct area.

The BBS is given to the area supervisor. The supervisor controls the delivery and returns the BBS signed to the Cutting and Bending Office.

6 Health and Safety

- All persons must follow the Contractor's health and safety plan NH 01 P00 JV HMS 0001 and any subsequent revision of the same.
- All persons working in the construction areas are requested to wear PPE (Personal Protective Equipment).
- All persons engaged with rebar cutting, cleaning rebar, using grinding machines and chiselling of concrete have to wear in addition gloves and protective goggles.
- Adequate lighting must be installed for night shift.
- All electrical equipments (installations) must have GFCI (Ground Fault Circuit Interrupter).
- All personnel shall attend the Contractor's training sessions.

NHB – JV		Lot				Sc	Section		Issuer		Type			Number				Ind.
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B	2005-03-31	K.Lindenbach	R.Eymery	F.Guinchard	Revised as per Consultant's Comments
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HYDRO-POWER PLANTS EXECUTIVE AUTHORITY (HPPEA)

Naga Hammadi Barrage Development Consultants (NHBDC)

NEW NAGA HAMMADI BARRAGE AND HYDROPOWER PLANT

Lot 1 – Civil Works

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Naga Hammadi Barrage Joint Venture (NHB-JV)

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Method Statement

Concrete Repairs & Concrete Finishing

Originator: NHB JV	First issue date: 2005-01-31					Page No. 1 of 7						
	Reference					Identification Number						
	Lot	Sc	Section	Issuer	Type	Number	Ind.					
	N H 0 1	P	0 0	J V	M S P	1 0 6 9	B					

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Appendix 1 – Repair Table

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1 Introduction

This method statement aims:

- to detail the standard procedures for concrete repairs and finishing for all concrete structures of the new Naga Hammadi Barrage,
- to serve as a reference document for the issue of specific procedures to be developed for any particular occurrence when appropriate.

2 Reference documents

2.1 Contractual documents

Particular Technical Specifications

- Vol. 3, Part II, Section 5 "Concrete" Chapter 5.17 Repair of Defective Concrete

2.2 Other Documents

Manufacturers' data sheets and instructions for preparation and application of special mortars, grouts, resins and associated products.

3 Resources

3.1 Supervision

Concrete repairs and concrete finishings are supervised by Site Engineers / Site Supervisors under the responsibility of the Works Managers / Section Managers who define the type of repairs and/or finishings to be performed.

Upon request of the Site Manager / Works Managers / Section Managers, technical assistance will be provided by the JV Technical Department and / or the JV Site Laboratory.

3.2 Personnel and Equipment

Necessary resources (labour and equipment) are to be defined and mobilised on a case per case basis.

Repairs are to be done by trained and experienced people.

3.3 Materials

Only approved materials are to be used for concrete repairs and concrete finishings.

- Sika Latex MSF 1085 A Additive for Mortar
- Sikagrout 200 MSF 1081 B Non Shrink Grout
- Sikagrout 214 MSF 1094 A Non Shrink Grout
- Masterflow 524 M MSF 1093 A Non Shrink Grout

4 Repair Works

4.1 General

After identification of the type of repair, a NCR has to be submitted to the Employer / Consultant containing the successive steps/methods to meet the time schedule requirements (PTS 5.17.1)

No repair work shall be carried out before the Employer/Consultant has inspected the defective area.

A RFI should be issued according to the already approved Checklist.

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The successive steps for any repair and / or finishing are:

- identify the type of repair to be done,
- proceed with the preparation works (activity A),
- apply primer or bonding agent when appropriate (activity B),
- apply the repair material (activity C),
- proceed with curing (activity D).

Typical repairs or finishings are:

- tie holes and anchor holes,
- honeycombs up to a depth of 50mm,
- honeycombs with a depth of more than 50mm.

The successive steps for each of these are detailed by the attached table (see appendix 1).

4.2 Preparation Works

4.2.1 Preparation "AA"

For tie and anchor holes.

Remove PVC and anchor steel cones and clean the tie or anchor hole by air blowing.

Wet thoroughly the area before the holes are packed solid and tight with dry mortar.

4.2.2 Preparation "AB"

For honey combs

Determine areas to be repaired by visual inspection and hammer sounding.

Mark the limits of area where concrete is suspect.

Cut edges of marked area perpendicular to the surface to a depth of not less than 20mm to avoid feather edging.

Cut out and chip away poor quality concrete until sound concrete is found. Remove all loose particles by air blowing and ensure that the surface is left in rough condition.

Wet thoroughly the surface before application of mortar or concrete.

Where reinforcement is encountered, the hole must be deepened by at least 15mm (repairs type CC, CE and CF) or 25mm (repair CD) beyond the steel rebar .

4.2.3 Preparation "AC"

Same preparation works than "AB" with the exception of wetting.

4.3 Bonding Coat or Primer

4.3.1 Bonding "BA"

The bonding coat consists of site mixed cement (CEM I 42,5 R LA or CEM III B 32,5 N LA), fine sand passing sieve 2mm, latex based compound and water. Mixing is to be done with a low speed drill mounted with an appropriate paddle to obtain a fluid paste consistency.

Mix proportions:

- One volume of cement CEM I 42,5 R LA (or CEM III B 32,5 N LA) for one volume of fine sand,
- Three volumes of water for one volume of latex based compound.

Add appropriate quantities of dry premix of cement and sand to the latex solution while stirring until the required consistency is attained.

The bonding coat paste shall be brushed into the prepared and pre-wetted (saturated surface but no ponding water) slot or surface. The thickness of the bonding film shall be 1 to 2mm. The repair mortar

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shall be applied immediately after ("wet on wet") before bonding coat dries otherwise this coat will act like a bond breaker instead.

If pre-packed repair mortar is used, the application of primer coat may not be required since the mortar itself can be used as primer agent (see manufacturer's data sheet and instructions).

4.4 Application of Repair material

4.4.1 Filling of Holes with Dry Mortar "CA"

The dry packing mortar shall have a low water-cement ratio to reduce shrinkage. This mortar consists of cement CEM I 42,5 R LA or CEM III B 32,5 N LA, sand passing sieve 4mm and a solution of latex bonding compound and water.

Mix proportions:

- One volume of cement CEM I 42,5 R LA (or CEM III B 32,5 N LA) for three volumes of fine sand,
- Three volumes of water for one volume of latex based compound.

Mortar is to be packed in the hole and compacted using a blunt stick and a hammer.

4.4.2 Site Mixed Mortar "CB"

The repair mortar shall have a low water-cement ratio to reduce shrinkage. This mortar consists of cement CEM I 42,5 R LA or CEM III B 32,5 N LA, sand passing sieve 4mm and a solution of latex bonding compound and water.

Mix proportions:

- One volume of cement CEM I 42,5 R LA (or CEM III B 32,5 N LA) for three volumes of fine sand,
- Three volumes of water for one volume of latex based compound.

Add appropriate quantities of dry premix of cement and sand to the latex solution while stirring until the mortar will stick together when molded by hand into a ball (dry pack consistency).

To reduce shrinkage, the mortar should stand for half an hour after mixing and should be remixed prior to use.

Place the mortar in approx. 10mm thick layers. Each layer shall be thoroughly compacted over the surface and each underlayer shall be scratched to facilitate bonding with the next layer. There shall be no delays between successive layers.

Curing shall start immediately after surface finishing has been completed.

4.4.3 Site Mixed Mortar "CC"

Follow the same than "CB" till placement.

Place the mortar in approx. 20mm thick layers and compact it into the box-out, screeding off to protrude slightly from the surrounding surface. Leave the plastered area for 1 to 2 hours before finishing by removing the excess mortar and make the patch flush with the surrounding surface.

Curing shall start immediately after surface finishing has been completed.

4.4.4 Repair with concrete "CD"

Large surface or volume repairs are to be made with concrete.

The technical department and / or laboratory are to be consulted to choose the right mix.

4.4.5 Grouting with non shrink cementitious grout "CE"

Grouting is to be done using non shrink cementitious grout.

The grout is packed in 25kg bags; shelf life is min. 6 months for unopened bags.

The entire content of the bag is to be added to the pre-measured quantity of water while mixing. Water quantity cannot be more than the maximum water content recommended by the manufacturer.

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Mix using a hand drill machine equipped with an appropriate paddle to obtain an homogeneous and flow able consistency (use always a full bag for mixing).

Fill the box-out to be repaired by pouring. Watertight forms may be required. Where appropriate vent pipes are to be installed to eliminate trapped air.

4.4.6 Filling with Epoxy Mortar "CF"

Solvent free transparent two components epoxy resin with low viscosity is to be used. Resin is to be packed in 1kg kits. Shelf life stored in dry condition is not less than 12 months.

Mixing of the two components epoxy resin, addition of dry sand and placing are to be done as per the manufacturer's recommendations and instructions.

4.5 Curing

4.5.1 Curing or Repairs with Cementitious Materials "DA"

Curing is to be done with water.

Horizontal and vertical repaired surfaces are to be covered with moistened burlap protected by plastic sheeting to limit evaporation and maintain a humid environment during the curing period (not less than 3 days).

The immediate and appropriate curing is a must for successful and durable repairs with cementitious mortars, concrete and / or non shrink grout.

5 Quality Control

Areas to be repaired are to be inspected by the Site Engineer / Site Supervisor in charge before the application of any bonding or primer.

For standard repairs such as tie and anchor holes no hold point is applicable.

For non standard repairs and more specifically for the ones where reinforcement is exposed a "Request for Inspection" is to be issued for the approval of the prepared surface before the application of any bonding or primer in accordance with the related Inspection and Test Plan.

6 Safety Provisions

All safety precautions applicable to concrete works are to be observed including but not limited to the following:

- suitable ladders, scaffoldings and / or working platforms for safe access,
- any particular precautions as per the manufacturer's safety data sheet (MSDS) for special products,
- condition of powered hand tools.

7 Environment Provisions

All environment precautions applicable to concrete works are to be observed.

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Appendix 1 – Repair Table

Item	Type of Defect	Repair Method	Preparation	Primer or Bonding	Application	Curing
1	Tie holes and anchor holes	Fill tie holes to be filled and patched with dry packed mortar in the very days after formwork stripping or removal of the anchoring cones.	AA	none	CA	DA
2	Honeycombs up to a depth of 50mm	Dry packing with low water content cementitious mortar	AB	BA	CB	DA
3	Honeycombs or repairs with a depth of more than 50mm	Dry packing with low water content cementitious mortar	AB	BA	CC	DA
4	Honeycombs or repairs with a depth of more than 50mm	Repair using standard concrete mix or mix with small aggregates only	AB	none	CD	DA
5	Honeycombs or repairs with a depth of more than 50mm	Repair using non shrink cementitious grout	AB	none	CE	DA
6	Honeycombs or repairs with a depth of more than 50mm	Repair using epoxy mortar	AC	non	CF	None

Item 1 to 4 to be used for common repair cases. Item 5 to be used in congested uniformed when the placing of mortar or concrete is impossible. Item 6 to be occasionally used if particular very high strength is required.

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Naga Hammadi Barrage Development Consultants (NHBDC)

NEW NAGA HAMMADI BARRAGE AND HYDROPOWER PLANT

Lot 1 – Civil Works

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Naga Hammadi Barrage Joint Venture (NHB-JV)



Method Statement Formwork for Elevated Structures

Originator: NHB JV	First issue date:						Page No. 1 of 9									
	Reference						Identification Number									
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1 Introduction

This method statement describes the detailed steps for the construction and preparation of vertical formed surfaces and construction joints in elevated structures.

For the formwork, standard material out of the PERI or SGB material stock will be used.

The supporting brackets used for climbing are PERI material and locally made for SGB.

2 Reference Documents

2.1 Contractual Documents

Particular Technical Specifications

- Vol. 3, Part II, Section 5 "Concrete"

2.2 Other Documents

This document shall be read in conjunction with the latest revision of the following documents:

- Related concrete outline drawings Type (C)
- Related rebar drawings Type (R)
- Method statement for Concrete Placing NH01 P 00 JV MSP 1046
- Method Statement for Concrete Repairs & Concrete finishing

3 Resources

3.1 Equipment

Type

- Hand Tools
- Lifting equipment

3.2 Personnel

For one Formwork Team:

- 1 Foreman
- 2 Headman
- 15 -20 Worker

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4 Materials

Type	Quantity	Remark
• Standard Formwork System Peri,		Type Vario
• Standard Brackets System Peri		Type SKS180
• Standard Formwork System SGB		MK II Soldier and DU-AI S / T 150 Beams
• Specially made brackets for SGB		As per DWG-5011
• Expanded Metal Sheets + Supporting rebars diameter 16		Type 615 (same as for foundations)
• Sawn Wood Boards 25 mm		For F 1
• Plywood 21 mm		For F1, F2 and F3
• Form Release Agent		NH 01 P 00 JV MSF 1058 A
• Binding Wire		NH 01 P 00 JV MSF 1071 A
• Concrete B25 or B30, as specified on the approved drawings		Mix Design: according to the uses
• Access Stairs towers		To be installed according to Methods Drawings in each case

5 Design

The formwork and brackets have been designed for a concrete pressure of 25 kN/m² and a concrete lift speed of max. 50 cm/hr for elevated structures.

Maximal deflection of expanded metal : 20 mm

Maximal deflection of plywood : 1 mm

Maximal deflection of sawn board : 3 mm

6 Execution Instructions

6.1 Work Sequence

6.1.1 Assembling of Formwork Panels Peri System

The panels comprise horizontal SRZ twin-channel steel wallings, vertical GT 24 timber lattice girders and a plywood or sawn board facing material.

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The sequence is as follows:

- Prepare timber or concrete fabrication platform.
- Space SRZ walings at correct centers on the platform.
- Positioning of GT 24 girders on walings at required centres.
- Fix internal girders to waling using Hookstrap 24.
- Position and centralize plywood / sawn board, except for panels which are used for construction joints, provisionally securing with nails, then fixing with torx form lining screws at specified centres.
- Fix crane splice GT 24, secure with pin and lift panel away. Repeat steps 2.1 to 2.5 for subsequent panels.

6.1.2 Assembling of Formwork Panels SGB System

The panels comprise horizontal DU-AI S / T 150 beam, vertical MK II Soldiers and a plywood or sawn board facing material.

The sequence is as follows:

- Prepare timber or concrete fabrication platform.
- Marking of the MK II Soldier spacing position
- Positioning of the MK II Soldier
- Marking of the DU-AI S / T Beam spacing position on the soldier
- Positioning of DU-AI S / T Beams.
- Fixing of DU-AI S / T Beams with Universal Clamps
- Fix Crane Clamps.
- Position and centralize plywood / sawn board, except for panels which are used for construction joints, fixing with nails and screws at specified centres.

6.1.3 Climbing with PERI formworks

- After concrete has reached a sufficient strength, stripping of formwork (see 6.1.7)
- Dismantling of tie bars
- Sliding of Peri panels in lift up position when the panels are on SKS brackets, removal by crane when the panels are on shaft platform
- Dismantling of positioners for anchor screws
- Fixing and bolting of adapting cone for anchor screws
- Checking by the Superintendent/ General Foreman of the correct installation of all the adapting cones for the next lift
- Lifting of each panel with brackets and fitting to the installed adapting cones; and securing by safety pin. **NO LIFTING BEFORE CONCRETE HAS REACHED A STRENGTH OF 15 MPa.**
- After complete lifting of brackets, inspection by Superintendent of the safety of the platforms, if handrails are all in place, if access by staircases is done correctly
- Applying of form release agent
- Installation of anchor screws for next lift

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6.1.6 Tying and Supporting SGB

- Placing and adjustment of panels will be done by using standard push pull props
- Trough tie rods for inner walls, lost tie-rods for outer walls will be used for tying formworks. Sketch of lost tie-rod system is attached to this Method Statement

6.1.7 Dismantling

After reaching the required minimum strength of concrete, which is 40% of the nominal 28 day compressive strength, the formwork will be dismantled. The concrete strength will be verified by the laboratory, which will test the early strength cubes. The concrete for those cubes have to be taken out of the last delivery. The cubes have to be stored on top of the concrete and cured and protected in the same way as the structure.

See paragraph "climbing" for the sequence of works.

Holes of anchoring screws and through tie rods shall be closed as per Concrete Repairs Method Statement. Holes on F1 finishing's will be closed with repair mortar as per Repair Method Statement. Holes on F2 finishing's will be closed with precast concrete cones.

6.1.8 Construction Joints

Where necessary after removing the expanded metal sheets, the construction joint surface shall appear as shown on the west side of the southern mock-up. The surface shall be rough and clean and in accordance to the requirement of the PTS Clause 5.11.1.1. d. Chiselling or scabbling is not required.

Before casting the neighbour pour the surface must be cleaned by high-pressure air end pre-wet.

7 Health & Safety

- Safe storage of panels when on ground
- Provision of correct access (stair towers)
- Regular inspection of the platforms, handrails, accesses
- All persons have to follow the Contractors Health and Safety Plan NH01 P 00 JV HMS 0001 latest revision.
- All persons working in the construction areas shall be required to wear PPE (Personnel protection equipment).
- Adequate lighting must be installed for night shift.
- All electrical installations must have ground fault circuit interrupter.
- All personnel shall attend the Contractors Safety Training Sessions.

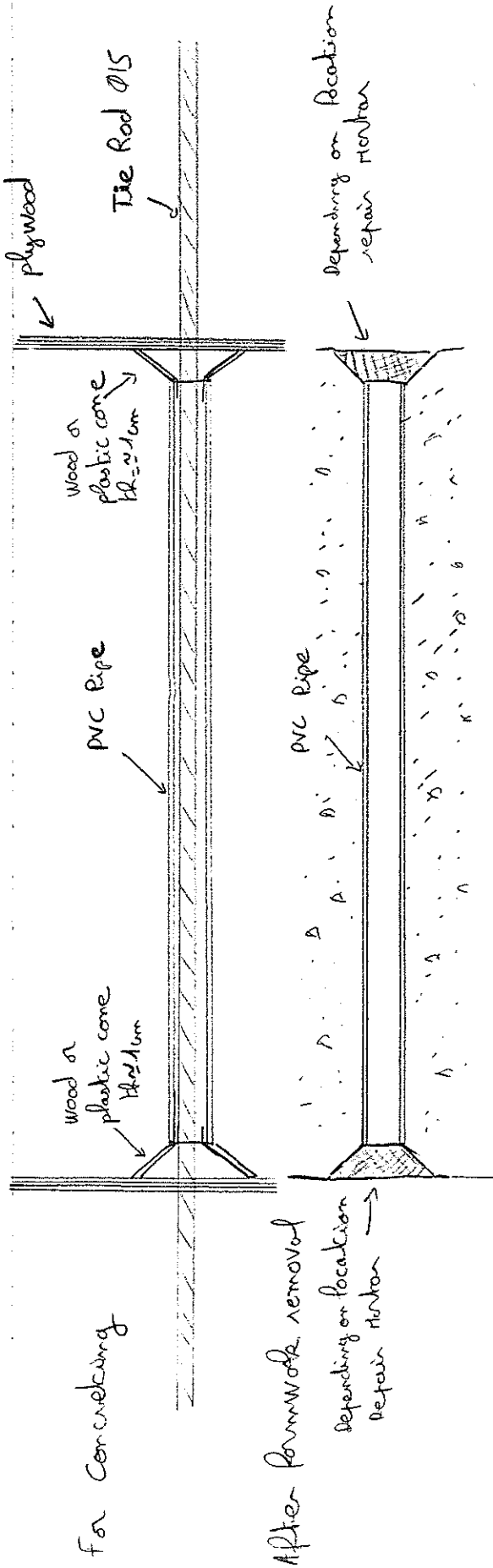
8 Quality (Inspection, Testing and Documentation)

The full inspection and testing procedure for formwork works is described in NH 01 P 00 JV ITP 0031.

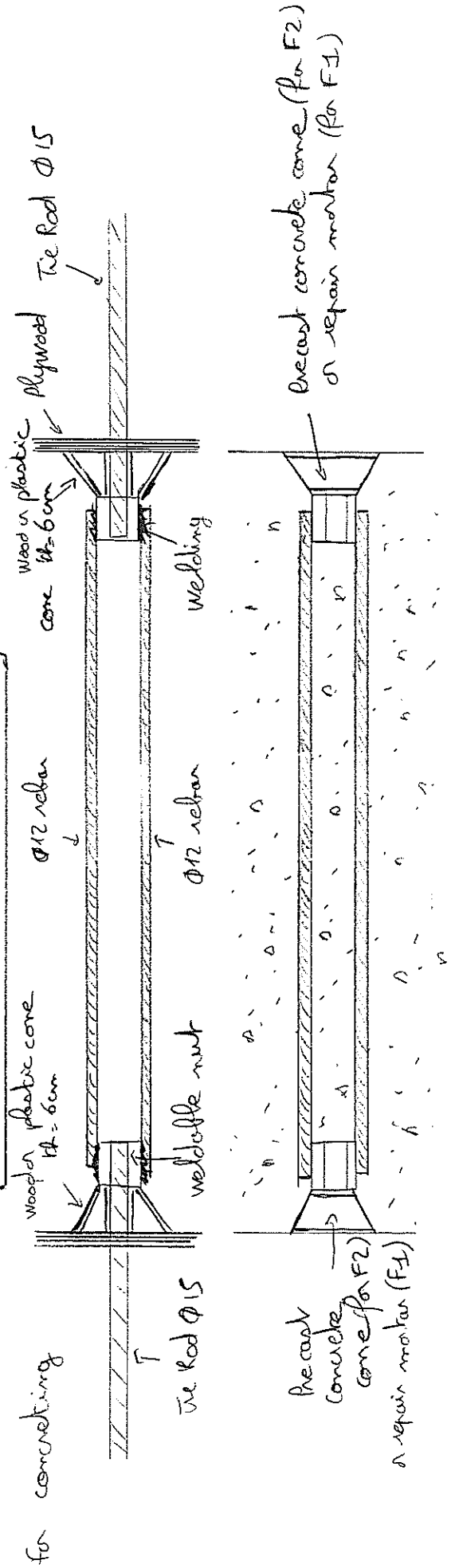
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AOE 18.03.05

SKETCH OF TROUGH TIE RODS



SKETCH OF LOST TIE-RODS



APR 2003 05

AREA OF USE OF LOST/TROUGH TIE RODS

Type of Wall \ Type of Tie Rod	TROUGH TIE ROD WITHOUT MORTAR	TROUGH TIE ROD WITH MORTAR	LOST TIE-ROD
Outer Wall in contact with water			X
Inner wall water on both sides (ballasting chambers)	X		
Inner wall backfill on both sides (backfilled chambers)		X	
Inner wall air on both sides		X	
Inner wall air / water			X
Inner wall water / backfill			X
Inner wall air / backfill		X	

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NEW NAGA HAMMADI BARRAGE AND HYDROPOWER PLANT

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Naga Hammadi Barrage Joint Venture (NHB-JV)

 **BILFINGER BERGER**

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Method Statement

Placing of Rebars into existing Concrete

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10 Safety Provisions

8

11 Environment Provisions

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1 Introduction

This method statement aims:

- to detail the standard procedures for placing of new rebars into existing concrete structures of the new Naga Hammadi Barrage Project,
- to serve as a reference document for the issue of specific procedures to be developed for any particular occurrence when appropriate.

2 Reference Documents

2.1 Contractual Documents

Particular Technical Specifications

- Vol. 3, Part II, Section 5 "Concrete" Chapter 5.7 (steel reinforcement)

2.2 Other Documents

Manufacturers' data sheets and instructions for preparation and application of non shrink and epoxy grouts.

3 Resources

3.1 Supervision

Placing of new rebars in existing concrete is supervised by Site Engineers / Site Supervisors under the responsibility of the Works Managers / Section Managers who define the procedure to be used.

Upon request of the Site Manager / Works Managers / Section Managers, technical assistance will be provided by the JV Technical Department and / or the JV Site Laboratory.

3.2 Personnel and Equipment

Necessary resources (labour and equipment) are to be defined and mobilised on a case per case basis.

Placing of new rebars and grouting is to be done by trained and experienced people.

3.3 The principle Activities will be involved

By grouting with cement based non shrink grout.

- Hole drilling, Atlas Copco pneumatic rock drill RH 571-5L, drilling bits 1600 mm x 40 mm
- Cleaning the hole by blowing out the hole with air pressure, Atlas Copco compressor XA136 Dd FBAC
- Preparing the non shrink grout
- Filling the non shrink grout into the drilled cleaned hole
- Insert the rebar
- Curing

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4 Method to be used

4.1 General

Due to different reasons starter bars or inserts could be missing in the already build concrete structures. The reason could be changes of design requirements after execution, misplaced starter bars or damaged ones.

In all mentioned cases the provision of correct placed and sufficiently dimensioned rebar is required after execution of the main concrete elements.

5 Grouting Works with Non Shrink Grout

5.1 General

A RFI should be issued according to the already approved Checklist.

The successive steps for any grouting and rebar placing.

- identify the type of non shrink grout have to be used,
- proceed with the preparation works,
- mixing of the non shrink grout,
- apply the non shrink grout,
- insert the rebar,
- proceed with curing.

5.2 Material to be used

Only approved materials are to be used for grouting.

- | | | |
|--------------------|------------|-------------------------------|
| • Sikagrout 200 | MSF 1081 B | Non Shrink Grout Cement based |
| • Sikagrout 214 | MSF 1094 A | Non Shrink Grout Cement based |
| • Masterflow 524 M | MSF 1093 A | Non Shrink Grout Cement based |

5.3 Preceding Works

The surface of the existing concrete has to be cleaned well and prepared for drilling.

Drilling

In general the diameter of the holes to be drilled should be 5 – 10 mm larger than the maximum rebar diameter which will be replaced. The depth of the hole depends on the diameter and the grouting system.

To ensure sufficient anchorage length of the rebars, the hole to be at least the depth of the minimum anchorage length, as given by the table on the relevant reinforcement drawing.

Drilling with an Atlas Copco pneumatic rock drill RH 571-5L and a drill bit 1600 mm x 40 mm

Borehole cleaning

Optimum performance requires rough sides and dust free holes cleaning with air pressure. Atlas Copco compressor XA136 Dd FBAC

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5.4 Preparation Works

5.4.1 Preparation

Before carrying out any grouting operations select the correct non shrink grout for the application and installation methods.

5.5 Preparation for Grouting

Ensure sufficient non shrink grout (not more than 6 months old) is available for the work to be executed.

Check that mixing equipment is suitable and in good working order. Use a drill with paddle with a speed of 300 – 400 rpm.

Ensure adequate potable water is available for mixing.

5.5.1 Hot Weather Grouting

If grouting is to take place in the open, store bags of non shrink grout under shade; shade the area to be grouted, and ensure that a supply of cool or chilled water is available to reduce the mixed non shrink grout temperatures to 25 – 30 °C for a good flow ability.

5.5.2 Mixing of Non Shrink Grout

Before mixing begins, ensure that all standing water in the drilled hole is removed.

Use a drill and paddle with a speed of 300 – 400 rpm, mixing in a 30 Liter. pail will be suitable.

The mixing setup must be able to produce a continuous supply of freshly mixed non shrink grout once the pour starts.

Damp down the inside of pail with water prior to mixing the initial batch of grout.

Add to first the required quantity of water which is needed to the pail then start the mixing by slowly adding the powder of the bags are needed. Mix for about five minutes up until a uniform lump free consistency is achieved.

In hot weather the mixing operation should take place under shade.

5.6 Application of Non Shrink Grout

5.6.1 Filling of drilled Holes

Fill the non shrink grout in to the drilled hole (2/3 of the length) and insert the rebar carefully.

5.7 Curing

5.7.1 Curing of Non Shrink Grout

As soon as the non shrink grout is placed and the rebar is insert, cover exposed areas with wet Hessian for several days.

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6 Method to be used by placing of Rebars with Epoxy based Mortar when the drilled Holes is not deep enough

6.1 General

See section 5.1

6.2 Preceding Works

The surface of the existing concrete has to be cleaned well and prepared for drilling.

Drilling

The diameter and the length of the holes to be drilled with various diameters is different, see attached detailed info from Hilti.

Drilling with a Hilti TE 76, with the required diameter of the drill bit.

To ensure sufficient anchorage length of the rebars, the hole has to be diameter and minimum depth, as given by the data sheet from Hilti. Please see MSF 1095 A Epoxy based Mortar.

Borehole cleaning

Optimum performance requires rough sides and dust free holes cleaning with air pressure. Atlas Copco compressor XA136 Dd FBAC

7 Material to be used

Only approved materials are to be used for injection.

- Hilti HIT – RE 500 MSF 1095 A Epoxy based mortar

8 Injection Works with Hilti HIT RE 500

8.1 General

A RFI should be issued according to the already approved Checklist.

The successive steps for any injection and rebar placing

- proceed with the preparation works,
- mixing of the epoxy Hilti HIT RE 500,
- inject the mixed epoxy based mortar,
- insert the rebar,
- proceed with curing.

8.2 Preparation Works

8.2.1 Preparation for injection

Ensure sufficient epoxy Hilti HIT – RE 500 injection adhesive is available for the work to be executed.

Check that mixing equipment is suitable and in good working order.

Make sure that the epoxy material is always stored in an air-conditioning room.

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8.2.2 Mixing and injecting of epoxy based mortar

Mixing the epoxy resin in accordance with the supplier's specifications.

8.2.3 Injecting epoxy based mortar into the drilled holes

Holes have to be carefully cleaned and must be dry at the time of epoxy resin injection.

The HIT – RE 500 mortar is injected by a special dispenser (Hilti HIT – MD 2000) with 330 ml cartridges.

Start injecting from the bottom of the hole (fill the hole 2/3 with epoxy mortar) and carefully insert the new rebar.

8.2.4 Installing the Rebar

After the epoxy resin is injected to the hole drive in the new rebar carefully within not more than 20 minutes and remove the overflow of epoxy resin if there is same.

8.2.5 Curing

After the rebar has set, allow no works till the epoxy based mortar has reached the sufficient strength (about 4 to 8 hours)

9 Quality Control

Placing of new rebar's to be inspected by the Site Engineer / Site Supervisor in charge before the work is executed.

For the grouting of non shrink grout and injection of epoxy based mortar a "Request for Inspection" is to be issued for the approval of the drilled holes and prepared rebar's before the application of non shrink grout or injection of epoxy based mortar is starting.

10 Safety Provisions

All safety precautions applicable to concrete works are to be observed including but not limited to the following:

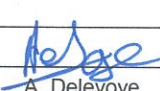
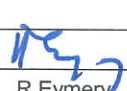
- suitable ladders, scaffoldings and / or working platforms for safe access,
- any particular precautions as per the manufacturer's safety data sheet (MSDS) for special products,
- condition of powered hand tools,
- all persons handling the epoxy resin must wear protective gloves and goggles.

11 Environment Provisions

All environment precautions applicable to concrete works are to be observed.

For disposal considerations of epoxy resin see Material Safety Data Sheet.

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 MINISTRY OF ELECTRICITY AND ENERGY (MEE)
 HYDRO-POWER PLANTS EXECUTIVE AUTHORITY (HPPEA)

Naga Hammadi Barrage Development Consultants (NHBDC)

NEW NAGA HAMMADI BARRAGE AND HYDROPOWER PLANT

Lot 1 – Civil Works

Approval Stamp:

MWRI / NHBDC		
Document Review		
Drawing No.:	Approval Sheet No.:	
Status of approval		
A	Approved	
AN	Approved except as Noted	
RR	Returned for correction and Resubmission	
name date		
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Approved:		
The approval of the drawings will not exonerate the Contractor from any responsibility in connection with the works.		

Status stamp:

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Naga Hammadi Barrage Joint Venture (NHB-JV)



Method Statement

Concrete placing boom erection

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1 Introduction

This Method Statement describes the sequence of works used for the erection of concrete placing booms and in particular:

- the preparation of the removable anchor screws,
- the erection of the placing boom,
- the tensioning and loading test of anchoring bars.

2 Resources

2.1 Personnel

The following standard team set-up will be assigned for the activities covered by this Method Statement. The number of teams will be adjusted to suit the work load.

For one shift:

- One supervisor,
- One foreman
- One team @ 4 labourers

2.2 Equipment

- Lifting equipment
- Small tools
- Hydraulic jack and pump with calibrated manometer

Equipment shall be adjusted to suit site requirements.

3 Materials

- Schwing Concrete placing boom SPB30 with all necessary accessories.

4 Sequences of work

4.1 General

The sequences thereafter described are as follows:

- the preparation of the removable anchor screws,
- the erection of the placing boom,
- the tensioning and loading test of anchoring bars.

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4.2 Preparation of the removable anchor screws

Removable anchor screws have to be embedded when pouring concrete as per relevant location drawings.

The anchors have to be smoothly unscrewed 1 day after concreting, and then tightened again immediately with square key and hammer.

Anchor screws have to remain in place until completion of all necessary works with the anchors. The threaded holes in the anchors have to be greased and protected with M30 bolts.

In specific case where the anchor screws have to be removed, holes have to be properly cleaned and anchor screws installed and tightened with square key and hammer. **But this is not recommended and has to be avoided.**

4.3 Erection of the placing boom

1. The cross-frame has to be lifted and installed in position. Cross-frame can be already linked to 1 column's element and top head. The crane can then be unloaded.
2. Rods M30 and double UPN160 are then installed and rods are tighten. The rods have to be painted in red on the 3 first cm at the bottom in the workshop. Correct installation and tightening of rods is done when the red colour is not visible, meaning that the rod has been screwed at least 3cm in anchor screw. Rods shall be inspected regularly and paint shall be renewed if damaged.
3. Ring and placing boom's arm can then be installed.

4.4 Tensioning and loading test of anchoring bars

For tensioning anchoring bars, hydraulic jack and second double UPN have to be installed.

Second UPN is installed above the first one. A coupler and a rod is installed on both bars and then screwed on the second UPN.

Hydraulic jack is then installed. It must be centred on the bottom double UPN.

A load of 22 tons has to be applied with the jack to the upper UPN, and before releasing jack, bottom nuts have to be tightened again.

4.5 Responsibilities

Site Supervisor:

- Installation of anchor screws and correct positioning and fixation,
- Protection of threaded holes with M30 bolts,

Placing Boom erection Supervisor

- Preparation of rods,
- Supervision of rods and placing boom erection,
- Checking the load applied with hydraulic jack and tightening of bolts
- Removal of the placing boom mast and replacing the protection of the threaded holes

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5 Health and Safety

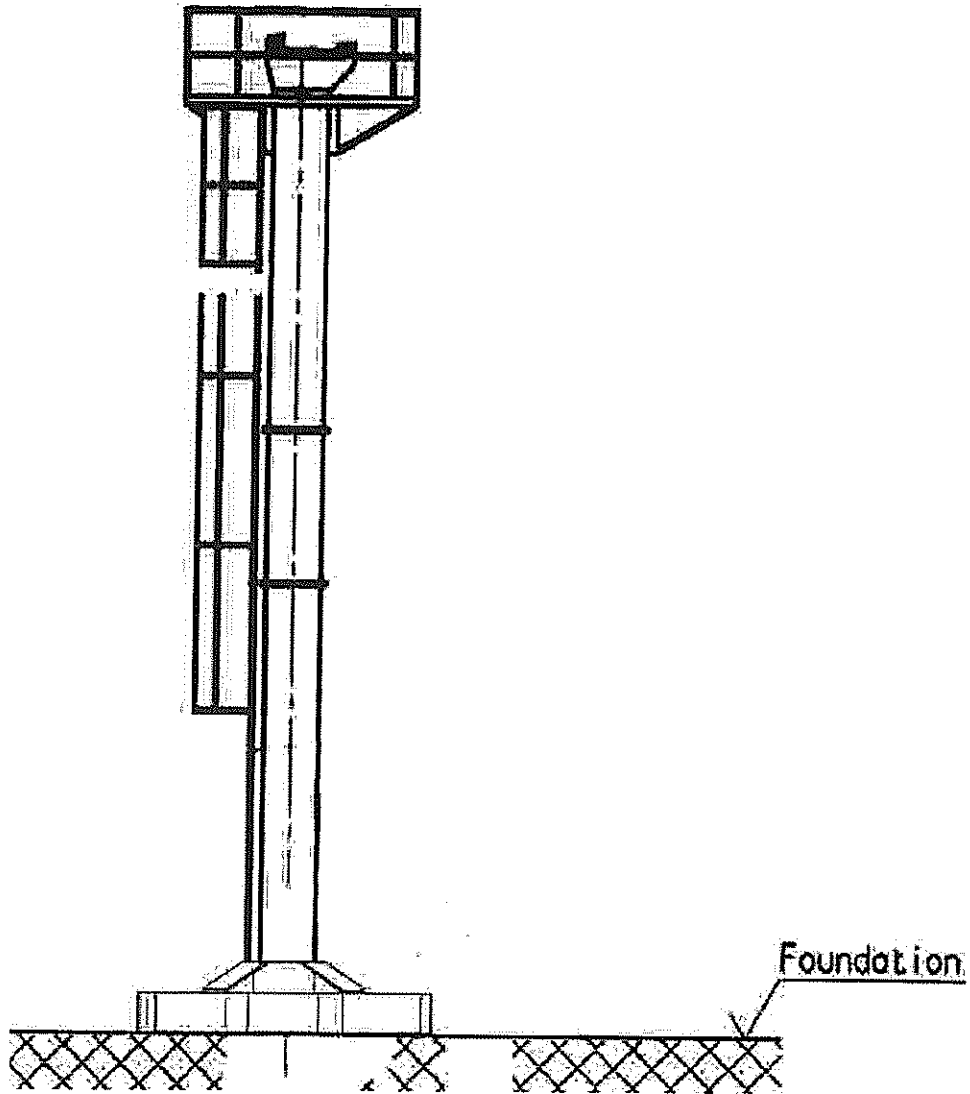
- All persons must follow the Contractor's Health and Safety Plan NH 01 P00 JV HMS 0001 or any subsequent revision of that document.
- All persons working in the construction areas shall be requested to wear PPE (Personal Protective Equipment).
- All persons engaged with concrete placing have to wear in addition gloves and protective goggles.
- Adequate lighting must be installed for night shift.
- All electrical equipments (installations) must have GFCI (Ground Fault Circuit Interrupter).
- All personnel shall attend the Contractor's training sessions.

6 Environment Protection

All construction and associated activities must follow the Environmental Management System and Environmental Protection Plan of the Contractor NH 01 P00 JV EMS 001 E (EPP) or any subsequent revision of that document. This includes all plans and procedures to the EPP and any revisions thereto.

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7 Annex 1 : Erection of placing boom

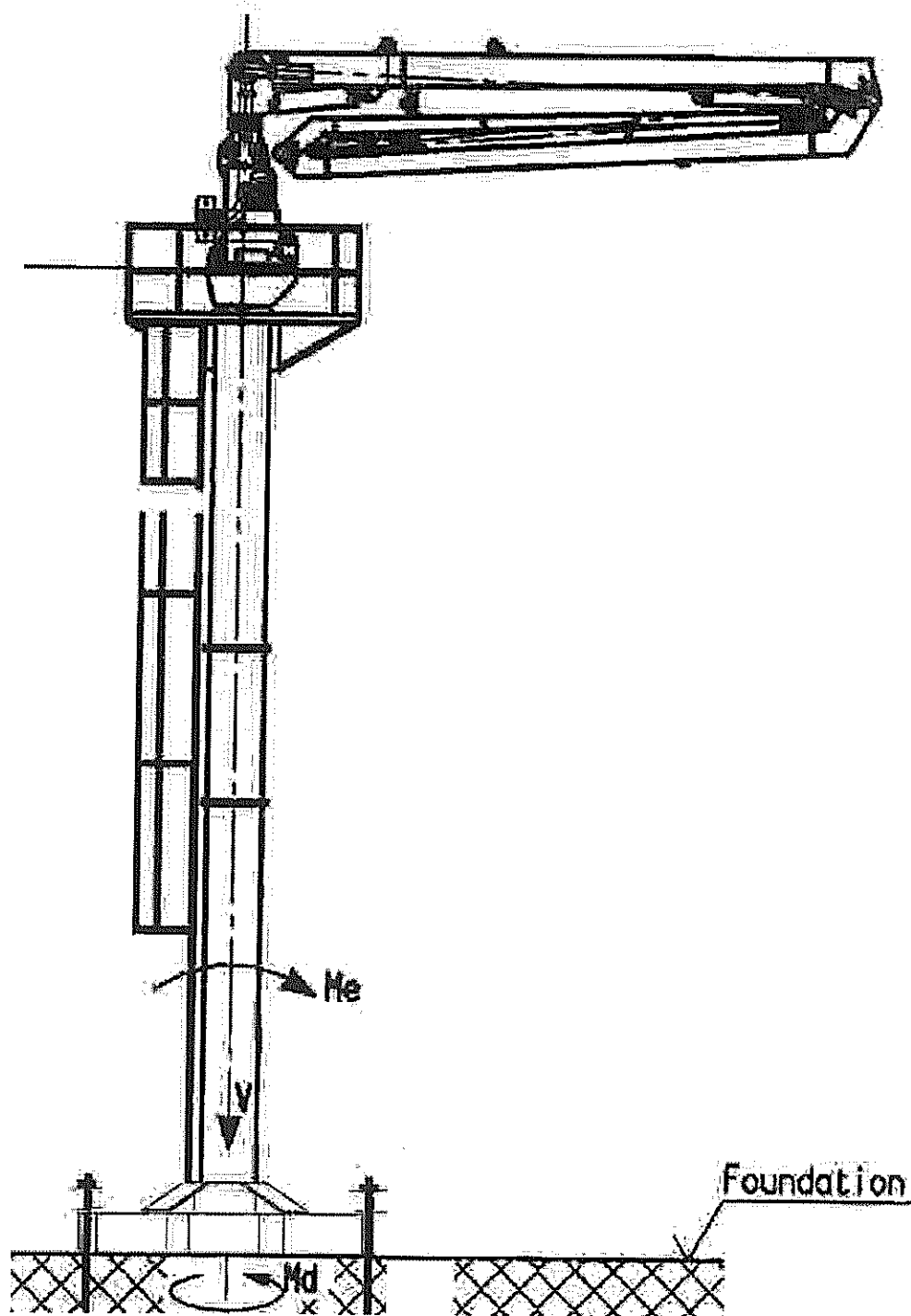


Installation of cross-frame and mast with top head

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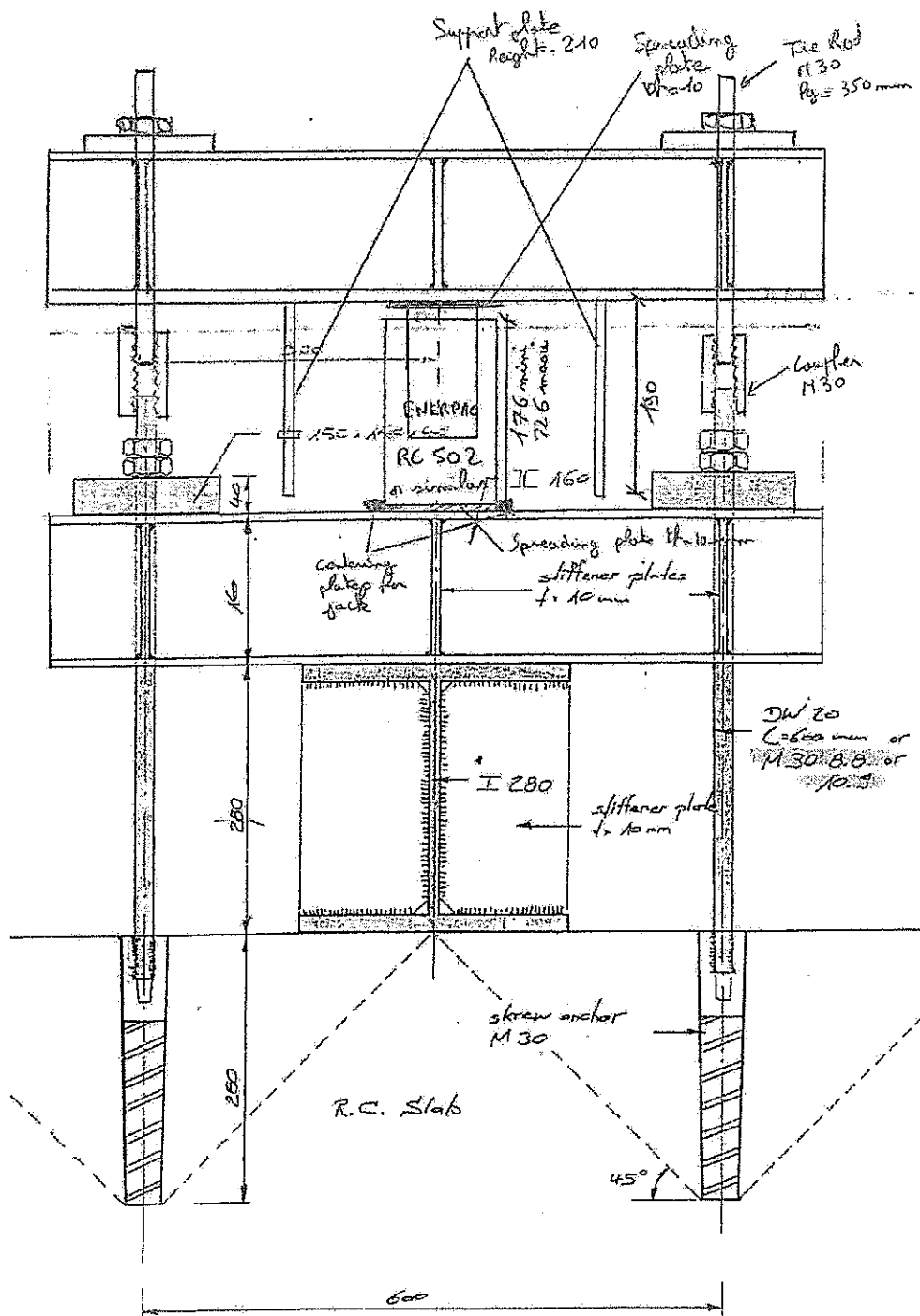


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Installation of ring and placing boom's arm

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Tensioning and loading test

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ARAB REPUBLIC OF EGYPT
MINISTRY OF WATER RESOURCES AND IRRIGATION (MWRI)
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Naga Hammadi Barrage Development Consultants (NHBDC)

NEW NAGA HAMMADI BARRAGE AND HYDROPOWER PLANT

Lot 1 – Civil Works

Approval Stamp:

MWRI / NHBDC		
Document Review		
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A	Approval	
AN	Approval except as Noted	
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Approved:		
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Naga Hammadi Barrage Joint Venture (NHB-JV)



Method Statement

Repair of Concrete Cracks on horizontal Areas with Epoxy Resin

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1 Introduction

This method statement aims:

- to detail the standard procedures for repairs of cracks in horizontal areas of concrete for all structures of the new Naga Hammadi Barrage.
- to serve as a reference document for the issue of specific procedure to be developed for any particular occurrence when appropriate.

2 Reference documents

2.1 Contractual documents

Particular Technical Specifications

- Vol. 3, Part II, Section 5 "Concrete" Chapter 5.17 Repair of Defective Concrete

2.2 Other Documents

Manufacturer's data sheets and instructions for preparation and application of epoxy resins.

3 Resources

3.1 Supervision

Concrete crack repairs are to be supervised by Site Engineers / Site Supervisors under the responsibility of the Works Managers / Section Managers who define the type of repairs to be performed.

Upon request of the Site Manager / Works Managers / Section Managers, technical assistance will be provided by the JV Technical Department and / or the JV Site Laboratory.

3.2 Personnel and Equipment

Necessary resources (labour and equipment) are to be defined and mobilised on a case per case basis.

Repairs are to be done by trained and experienced people.

3.3 Materials

Only approved materials are to be used for the repairs of insufficient concrete cover.

- CONGRESIVE 1315 M MSF 1106 A Low – Viscosity Epoxy Resin

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4 Repair Works

4.1 General

After identification of the area of repair, a NCR has to be submitted to the Employer / Consultant containing the successive steps /methods to meet the time schedule requirements (PTS 5.17.1).

No repair work shall be carried out before the Employer/Consultant has inspected the defective area.

A RFI should be issued according to the already approved Checklist.

The successive steps for any repair are:

- identify the type of repair to be done,
- proceed with the preparation works,
- apply the repair material.

4.2 Preparation Works

4.2.1 Age of concrete which has to be repaired

The concrete should be at least 28 days old before the epoxy resin is filled or injected in to the cracks.

4.2.2 Preparation

Remove all the dirt in the cracks and clean the cracks by air blasting, if it is necessary open the cracks more.

After cleaning surround the cracks with silicon (as a protection that the epoxy resin can not flow away).

4.3 Mixing of Epoxy Resin

The epoxy resin is supplied in two preweighed components, base and reactor.

Add reactor contents to the base component and mix thoroughly, using a slow speed drill fitted with a suitable mixing paddle, until a uniform colour is achieved.

4.4 Application of Epoxy Resin

After settings of the silicon make sure that the cracks are cleaned and dry.

Then pour the mixed epoxy resin very slow in to the cracks, continuo up to the cracks is completely filled.

Next day remove the silicon and grind the over standing material down to the concrete level.

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5 Storage of the Epoxy Resin

The epoxy resin components have to be stored in an air-conditioned environment.

6 Quality Control

Areas to be repaired are to be inspected by the Site Engineer / Site Supervisor in charge before the application of epoxy resin coat.

7 Safety Provisions

All safety precautions applicable to concrete works are to be observed including but not limited to the following:

- suitable ladders, scaffoldings and/or working platforms for safe access,
- any particular precautions as per the manufacturer's safety data sheet(MSDS) for epoxy resin base and reactor components,
- condition of powered hand tools.

8 Environment Provisions

All environment precautions applicable to Environmental protection plan

NH 01 P00 JV EMS 0001 E.

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